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LATHYRUS APHACA (FABACEAE), PREVIOUSLY UNREPORTED FOR TEXAS

¹Stanley D. Jones & ²Anton A. Reznicek

¹Botanical Research Center Herbarium (BRCH), P.O. Box 6717, Bryan, Texas
77802-6717 U.S.A., e-mail sdjones@startel.net

²University of Michigan Herbarium (MICH), North University Building, Ann Arbor,
Michigan 48109-1057 U.S.A.

ABSTRACT

Lathyrus aphaca C. Linnaeus, previously unreported in Texas has been collected in Kaufman County.

KEY WORDS: *Lathyrus*, *Lathyrus aphaca*, Fabaceae, Texas

Lathyrus is a genus of about 120 species distributed throughout temperate regions of the world except Australia (Correll & Johnston 1970). Nine species are now recorded for Texas (including two cultivated species): *Lathyrus aphaca* C. Linnaeus, *L. graminifolius* (S. Watson) T. White, *L. hirsutus* C. Linnaeus, *L. lanszwertii* A. Kellogg var. *leucanthus* (P. Rydberg) R. Dorn, *L. latifolius* C. Linnaeus [cultivated], *L. odoratus* C. Linnaeus [cultivated], *L. polymorphus* T. Nuttall subsp. *incanus* (J.G. Smith & P. Rydberg) C. Hitchcock and subsp. *polymorphus* var. *polymorphus*, *L. pusillus* S. Elliott, and *L. venosus* G.H. Muhlenberg ex C. von Willdenow var. *intonsus* F. Butlers & H. St. John. Beardsley & Browne (1972) first reported this European native new to the Southeast United States from LA, MS, and TN. It was not listed as occurring in Texas by Gould (1975), Hatch, *et al.* (1990), nor Jones, *et al.* (1997).

Isely (1990) provides easy characters to separate *Lathyrus aphaca* from the other species in our flora. The inflorescences consist of a raceme(s) with 1(-2) apical yellow flowers; no leaflets, the leafstalk consisting only of a tendril; stipules are foliaceous, 1-4 cm long \times (0.5-)1-3 cm wide, deltate-ovate to lanceolate. Additional characteristics include: annual; sprawling, suberect to slightly scandent unwinged stems 3-6(-10) dm long, glabrous; calyx 6-10 mm long, lobes subequal, lanceolate, exceeding tube; corolla 10-12 mm long; fruit short oblong, slightly upcurved, 2-4 cm long \times 4-7 mm wide, glabrous, impressed between seeds.

Specimen collected: UNITED STATES. Texas: Kaufman Co., GPS: N 32° 46' 19", W 96° 18' 41", 1.4 mi SE on TX 205 from its jct. with FR 1392, N of Terrell, 02 May 1997, S.D. Jones 12913 & A. & S. Reznicek (ASTC,BRCH,BRIT,MICH,TEX). *Lathyrus aphaca* was locally abundant and growing in large tangled mats in an open disturbed roadside ditch with alluvial clay soil. Associated taxa included *Castilleja*, *Lolium*, *Carex*, *Polytaenia*, *Spermolepis*, and *Oenothera*. Additional sites were observed in Delta and other northeastern counties but no additional specimens were collected.

ACKNOWLEDGMENTS

We thank Larry E. Brown (SBSC), William E. Fox III (TAES), and Gretchen D. Jones (USDA-ARS) for their helpful suggestions.

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EVALUATION OF RHIZOBIAL ISOLATES FROM *ALBIZIA LEBBECK* FOR TEMPERATURE TOLERANCE

Mohammad Athar & Shaikh Mohammad Shabbir

Land Resources Research Institute, Pakistan Agricultural Research Council, P.O. Box 1031, Islamabad-45500, PAKISTAN

Present Address: Department of Environmental Horticulture, University of California, Davis, California 95616 U.S.A.

&

Agriculture College, Azad Jammu and Kashmir University, Rawalakot, Azad Kashmir, PAKISTAN

ABSTRACT

A total of 40 rhizobial isolates capable of nodulating *Albizia lebbbeck* (L.) Benth. were obtained from thirteen locations in Pakistan with dominant communities of *Albizia* plantation, and were evaluated for temperature tolerance under laboratory conditions. Rhizobial isolates were grown on yeast-extract mannitol agar medium and incubated at 28, 32, 36, and 40° C for seven days. Distinct variations in temperature tolerance were observed for isolates obtained from different locations. While all isolates grew at 28° C and 70% at 32° C, higher incubation temperatures sharply reduced the proportion of isolates able to grow. Only three isolates from Punjab and two from Sindh were able to grow at 40° C. The information on temperature tolerance by *A. lebbbeck* root-nodule bacteria may be useful for the characterization of the strains. Selection of temperature-tolerant rhizobial strains may contribute greatly to the forest productivity under high temperature conditions and reforestation of degraded areas in the tropics.

KEY WORDS: tree legume, rhizobia, temperature tolerance, forest productivity

INTRODUCTION

Siris (*Albizia lebbbeck* [L.] Benth.) is a well known, fast growing tree of Pakistan. It is widely grown in the plains up to an elevation of 1200 m, in farmlands, along

roadsides, irrigated plantations, and riverine tracts. It grows on a variety of soils, but deep loamy soil is preferred. Its leaves contain 16.8-25.5% crude protein and are an excellent source of fodder (Quraishi, *et al.* 1993). *Albizia lebbeck* forms symbiotic associations with *Rhizobium*, and can fulfill its own nitrogen requirements. This symbiotic relationship also enriches the soil with nitrogen for succeeding crops. Moreover, it is a salt-tolerant plant and it can be cultivated in salt affected soil (Prinsen 1986).

Nitrogen-fixing efficiency of legumes is greatly altered by the environmental impacts on both host and symbiont (Barnet, *et al.* 1988; Bordeleau & Prevost 1994). Most studies on symbiotic performance of rhizobia under environmental stress have concentrated on herbaceous legumes within an agricultural context (Athar & Johnson 1996, 1997). Our knowledge about the constraints affecting *Rhizobium* symbiosis in woody legumes is very limited. Temperature can affect rhizobial persistence in inoculants during shipment or in storage, can influence survival in soil, and can limit both nodulation and nitrogen fixation (Graham 1992). High root temperatures will also delay nodulation or restrict it to the subsurface region, where temperatures are not as extreme. It has been shown for various plants grown in tropical and subtropical regions, that root temperatures in the range of 35° C to 40° C are detrimental to nodule formation and nitrogen fixation (Arayangkoon, *et al.* 1990; Hungria & Franco 1993; Hungria, *et al.* 1993; Kishinevsky, *et al.* 1992; La Favre & Eaglesham 1986; Michiels, *et al.* 1994). Effect of root temperature on nodulation and fixation by legumes is modified by strain of rhizobia (Arayangkoon, *et al.* 1990; Kishinevsky, *et al.* 1992; La Favre & Eaglesham 1986).

The productivity of legume trees depends upon their nitrogen-fixing potential in unfavorable soil conditions. Temperature, in conjunction with drought, is a serious problem, particularly in Pakistan (Athar & Johnson 1996). A detailed understanding of various environmental constraints on nitrogen-fixing potential of woody legumes is necessary to increase and obtain sustainable yields from forest plantations. The rhizobia isolated from *Acacia nilotica* (L.) Del. showed differences in survival at elevated temperatures (Athar 1994). The effect of temperature on rhizobia from other woody legumes of Pakistan is not known. The objective of the present investigation was to determine the effect of temperature on growth of indigenous rhizobia isolated from *Albizia lebbeck*.

MATERIALS AND METHODS

Nodulation in *Albizia lebbeck* was examined from various forest plantations of Pakistan with dominant communities of *Albizia* vegetation. The roots of young plants growing close to or under the canopy of adult plants were excavated and observed for nodulation. Details of the procedure for the retrieval of nodules from legume trees are provided elsewhere (Athar 1994). Some nodules were collected from the seedlings raised in plastic bags containing natural soil. Nodules selected randomly from each site were stored in small vials over silica gel for later isolation of root-nodule bacteria by the method of Somasegaran & Hoben (1994). A total of 40 isolates of rhizobia (Table 1) were obtained and maintained on yeast-extract mannitol agar slants at 5° C.

Table 1. Site, location, and elevation for rhizobial strains from *Albizia lebbeck*.

| Province/Site | Location | Elevation (m) | Strains |
|------------------|----------------------|---------------|--|
| Punjab | | | |
| Changa Manga | 31° 50' N, 73° 58' E | 190 | AL 10, AL 11, AL 12, AL 13, AL 14, AL 15 |
| Jhang | 31° 34' N, 72° 30' E | 170 | AL 16, AL 17 |
| Chichawatni | 30° 32' N, 72° 42' E | 160 | AL 18, AL 19, AL 20, AL 21, AL 22 |
| Khanewal | 30° 18' N, 71° 56' E | 140 | AL 23, AL 24, AL 25, AL 26 |
| Dera Ghazi Khan | 29° 50' N, 70° 15' E | 150 | AL 27, AL 28, AL 29 |
| Cholistan | 28° 15' N, 70° 45' E | 120 | AL 30, AL 31, AL 32, AL 33 |
| Sindh | | | |
| Shikarpur | 27° 57' N, 68° 38' E | 58 | AL 34, AL 35 |
| Khairpur | 27° 32' N, 68° 46' E | 62 | AL 36, AL 37 |
| Hyderabad | 25° 22' N, 68° 22' E | 27 | AL 38, AL 39, AL 40 |
| Tando Bago | 24° 47' N, 68° 58' E | 14 | AL 41, AL 42 |
| N.W.F.P. | | | |
| Mardan | 34° 90' N, 71° 46' E | 329 | AL 43, AL 44 |
| Kohat | 33° 34' N, 71° 27' E | 492 | AL 45, AL 46 |
| Dera Ismail Khan | 31° 54' N, 70° 54' E | 172 | AL 47, AL 48, AL 49 |

AL designation indicates that the rhizobial strain is from *Albizia lebbeck*.

All isolates were screened by Gram's staining and only those conforming to the description for the rhizobia (Somasegaran & Hoben 1994) were included for future testing.

Pure cultures of rhizobia were grown in yeast-extract mannitol broth for seven days at 28° C, diluted to 10^8 - 10^9 cells mL⁻¹ with sterile distilled water and 0.1 mL was streaked on yeast-extract mannitol agar plates (Somasegaran & Hoben 1994). The plates were replicated four times for each isolate and were incubated at 28, 32, 36, and 40° C for seven days. Growth was detected by visual inspection as positive (visible growth) or negative (no growth).

Table 2. Temperature tolerance by *Albizia lebbeck* root-nodule bacteria.

| Province | Total isolates | Temperature (° C) | | | |
|----------|----------------|-------------------|---------|---------|--------|
| | | 28 | 32 | 36 | 40 |
| Punjab | 24 | 24 (100) | 17 (71) | 11 (46) | 3 (13) |
| Sindh | 9 | 9 (100) | 7 (78) | 4 (44) | 2 (22) |
| N.W.F.P. | 7 | 7 (100) | 4 (57) | 0 (00) | 0 (00) |
| Total | 40 | 40 (100) | 28 (70) | 15 (45) | 5 (13) |

Values in parentheses are the percentages of tolerant isolates.

RESULTS AND DISCUSSION

Root nodules of *Albizia lebbeck* were observed at all sampling locations, indicating wide distribution of rhizobia in Pakistani soil. These rhizobia varied in their response to temperature tolerance (Table 2). All 40 isolates grew at 28° C. However, elevated incubation temperatures markedly reduced the proportion of isolates to grow. About 70% of isolates tolerated a temperature of 32° C and 15% of isolates showed growth at 36° C. The rhizobial isolates from *A. lebbeck* showed marked geographic localization. While none of the isolates from North Western Frontier Province (N.W.F.P.) could grow at temperatures of 36 and 40° C, three isolates from Punjab and two from Sindh were able to grow at high temperatures (Table 2). High temperature is known to influence the growth and survival of rhizobia. Differences among strains in tolerance to high temperatures have been shown for *Bradyrhizobium japonicum* (Boonkerd & Weaver 1982; Hartal & Alexander 1984; Kennedy & Wollum 1988; Kishinevsky, *et al.* 1992), *Rhizobium meliloti* (Toro & Olivares 1986), *R. leguminosarum* (Moawad & Beck 1991), and *R. tropici* (Martinez-Romero, *et al.* 1991).

More recently, various rhizobial strains have been characterized by their ability to grow under elevated temperatures. Athar (1993, 1994) examined temperature tolerance of *Lens culinaris* and *Acacia nilotica* rhizobia from Pakistan and observed clear differences in survival of indigenous rhizobia at temperature as high as 36 and 40° C. Michiels, *et al.* (1994) also indicated differences in cell viability of bean-nodulating *Rhizobium* strains to thermal stress. In the tropics, soil temperatures between 40 and 60° C are not uncommon. Some rhizobial strains from tree legumes can nodulate and fix nitrogen at temperatures as high as 40° C and could represent a genetic source for nodulation at high temperatures with other species (Hungria, *et al.*

1993). *Albizia lebbeck* is a drought resistant tree, and its associated rhizobia are exposed to very dry and hot temperature conditions. In summer, temperatures in some parts of Punjab and Sindh exceed 40° C. Thus, soil temperature may influence natural populations of root-nodule bacteria. However, it has been shown that some rhizobial strains isolated from tropical tree legumes were able to fix nitrogen at extremely high temperatures (Hungria, *et al.* 1993). The development of a methodology for selecting temperature-tolerant rhizobial strains may contribute greatly to the success of nitrogen-fixing symbiosis under high temperature conditions. Additional research is required to elucidate the genetics and physiology of these elite strains before including them as inoculants in the reforestation of degraded areas in the tropics.

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A TECHNIQUE FOR INVESTIGATING ROOT DISTRIBUTION

Joseph H. Robertson

Range Ecologist, Department of Environmental and Resource Sciences, University of Nevada, Reno, Nevada 89557 U.S.A.

ABSTRACT

A method of direct observation of root tips in the field is described. Covered holes served as moist chambers and root tips of nearby plants extended from the walls where they could be recorded and correlated with soil characteristics or phenology.

Most methods of root study are time consuming, destructive to the root system, or require artificial conditions. The method described here also has these advantages, but in only a limited degree. It is a technique for ascertaining root distribution relative to the soil surface or to soil horizons. It can be used, for example, to discover the time of resumption of root growth in the spring as a guide to time the application of systemic growth regulators and defoliators.

KEY WORDS: root growth, root distribution, root phenology

METHODS

In the first trial, cylindrical holes were dug, before spring growth, to a depth of 3 feet, and a diameter of 12-14 inches. Extraneous species were carefully removed at the crown, leaving only the plant of immediate concern near the hole. A 5-gallon bucket of water was placed in each hole with cloth wicks over the side to increase evaporation. Finally, the holes were covered with boards and mounded with earth.

At weekly intervals the holes were partially uncovered and the first appearance of root tips observed with the aid of a flashlight. If desired, rates of appearance by depths could be determined by marking each tip with a different colored toothpick at each inspection.

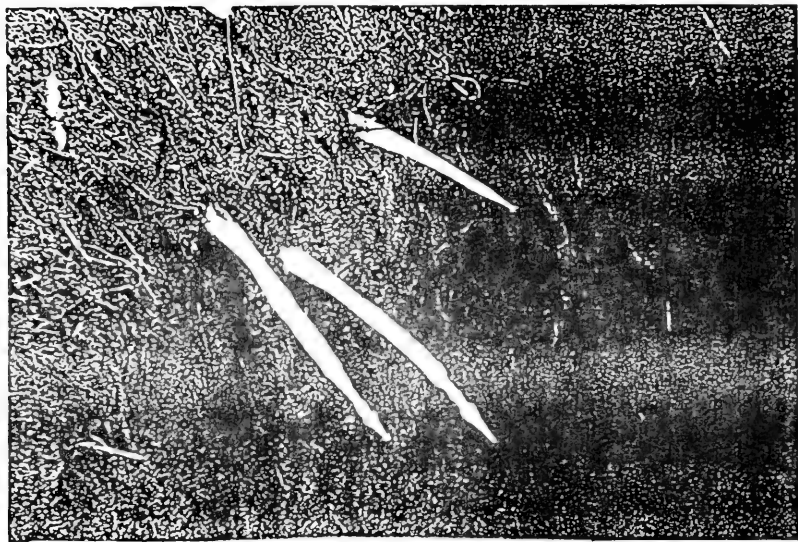


Figure 1. Nodal roots of Russian wildrye (*Elymus junceus* Fisch.) emerging from the trench wall 9-10 inches below the soil surface.

In a second trial, trenches were excavated into the water table in pure stands of exotic grasses to locate roots in the capillary zone. Some trenches were lined with sheets of polyethylene, and others with burlap. Planks and earth were used to exclude light, moderate the temperature, and maintain humidity in the trenches.

By partially uncovering a trench and sliding a ladder into the water, trench walls could be examined and the root tips charted or counted.

RESULTS AND DISCUSSION

The time of initiation of root growth was readily noted in the cylindrical holes, as was the density of root tips above the bucket.

Results with the trench technique were less satisfactory, primarily for two reasons. Difficulty of uncovering the trench discouraged frequent observation. More important was the propensity of small rodents to burrow under the cover. Where this occurred, the trenches were ventilated so that the moist chamber effect was lost. Root tips either failed to appear, or if emerged, died in the drier air.

The trench linings were detrimental in that they encouraged fungi and arthropods rather than root tips.

Tightly sealed holes and trenches afforded a good environment for root growth (Figure 1).

This offers a direct method of correlating root activity with site factors such as soil structure, temperature, or photoperiod.

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NODULATION CHARACTERISTICS OF SOME OF THE FORAGE AND BROWSE LEGUMES

Mohammad Athar & Shaikh Mohammad Shabbir

Land Resources Research Institute, Pakistan Agricultural Research Council, P.O. Box
1031, Islamabad 45500, PAKISTAN

Present address: Department of Environmental Horticulture, University of California,
Davis, California 95616 U.S.A.

&

Agricultural College, Azad Jammu and Kashmir University, Rawalakot, Azad
Kashmir, PAKISTAN

ABSTRACT

Nodulation was studied in 93 species within 25 genera used, or with potential for forage and browse. All the species in subfamilies Mimosoideae and Papilionoideae were nodulated. Nodules were not observed in all *Bauhinia* spp. in subfamily Caesalpinoideae. Nodules in most taxa were mainly distributed on the crown region of the primary root. The crown nodulation coupled with abundant leghaemoglobin, indicates the effectiveness of these nodules. Our next step is to test most promising legume species for pasture management and forage quality. Top pasture management blended with good animal husbandry may result in the improvement of the livestock industry.

KEY WORDS: Forage, browse, legumes, nodulation, taxonomy, livestock production

INTRODUCTION

In Pakistan, depending on the region, grazing grasses and legumes is an important practice like traditional feeding of freshly cut fodder (Dawson 1987; Rasheed & Athar 1997). The fertility return from animal excreta under grazing can be highly significant, especially in grass/legume systems in which the nitrogen cycle under grazing assumes considerable importance. Nitrogen fixation by nodulated forage and browse legumes can increase productivity of rangelands and marginal croplands. Nodulated legumes are not only self sustaining in their nitrogen requirement but they also add substantial amounts of nitrogen to the soil. Little is known about the yield, plant growth and

nitrogen fixation by indigenous and introduced forage legumes in Pakistan. Most studies on nitrogen fixation pertain to annual forage legume crops (Mohammad & Qamar 1988; Athar & Johnson 1996). Information about other forage legumes or their rhizobia is very limited in Pakistan. Even a comprehensive listing of forage legumes and their nodulating ability is not available. The present study was conducted to document potential forage and browse legumes of Pakistan with reference to their nodulating ability.

MATERIALS AND METHODS

Legume species growing under natural conditions were surveyed for their nodulating ability from Pakistan and Azad Kashmir. Wild legumes were examined under natural habitat while legumes of agricultural importance were observed from the cultivated fields. Most legumes examined included herbs, shrubs, and vines. Introduced legumes were studied in field trials of the Pakistan Agricultural Research Council and provincial forest departments. Some of the legumes which are primarily cultivated for their grain production also provide a good source of browse after harvesting the crop. Likewise, some tree legumes traditionally used for shade, timber, and fuel wood also hold promise for potential forage production (Brewbaker 1985). These kinds of grain and tree legumes were also included in the list. Nodules were distinguished from other kinds of morphological modifications or root malformation, and nodulation data were recorded. Legumes were identified by the specimens collected from the mature plants. The nomenclature and tribal classification are as described by Kirkbride (1986). Author citations are quoted following instructions of Brummitt & Powell (1992) as endorsed by the International Working Group on Taxonomy Database for Plant Science (TDWG).

RESULTS AND DISCUSSION

Table 1 gives results of 93 species within 25 genera distributed in twelve tribes of subfamilies Caesalpinioideae, Mimosoideae, and Papilionoideae. The nodules observed in these species confirmed earlier reports (Aguilar, *et al.* 1994; Allen & Allen 1981; Athar 1996a, 1996b, 1997; Brewbaker 1985; Faria, *et al.* 1994; Mahmood & Iqbal 1994; Subramaniam & Babu 1994). All the species in subfamilies Mimosoideae and Papilionoideae were nodulated. Nodules were not observed in all *Bauhinia* spp. in the subfamily Caesalpinioideae. Lack of nodulation has been reported in Caesalpinioideae (Allen & Allen 1981; Athar 1997; Faria, *et al.* 1994; Mahmood & Iqbal 1994).

Nodules in most of the taxa were mainly distributed on the crown region of the primary root. Nodule morphology in Papilionoideae and Mimosoideae coincided very much with the description of Athar (1996a), Corby (1988), and Mahmood & Iqbal (1994). Nodules varied from semi-globose to globose with streaked or smoothed surfaces, to elongated and branched forms with projections into finger-like or fan-shaped structures (Table 1). They occurred singly or as lobed structures. Nodules

were mostly pink or brown with reddish interiors. The crown nodulation coupled with abundant leghaemoglobin indicates the effectiveness of these nodules.

The use of naturally occurring browse species is a vital component of livestock production systems in many regions of the world. Tree leaves and pods form a natural part of the diet of many ruminant species and have been used traditionally as a source of forage for domesticated livestock in Asia, Africa, and the Pacific (Norton 1994). Tree legumes not only provide feed for ruminants, there are also reports of their inclusion in the diets of fish and poultry. The leaves, stems, and fruits may be used for grazing either as a complete food or as a supplement to other feed. In Pakistan, studies are needed on relative productivity from grazing legumes under intensive management in both the rainfed and irrigated conditions (Dawson 1987; Rasheed & Athar 1997). Such studies should focus on exploring special purpose forage legumes (Rumbaugh 1988), comparative production and feasibility of grazed and green-chop system of pasture management (Puckridge & French 1983). Top pasture management blended with good animal husbandry may result in the improvement of livestock industry. Our next step is to test most promising legume species for pasture management and forage quality. Some of the species will also be evaluated for their regeneration ability under periodic cereal cropping systems. The integration of livestock (sheep and/or cattle) will be necessary to optimize land use, grain and meat/fibre outputs, and nitrogen cycling. Grazing during the growing season enhances the establishment and persistence of legume components. Also, proper grazing management can particularly control undesirable weeds, optimizing seed production, and increased nitrogen cycling.

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Table 1. Nodulation characteristics of some of the forage and browse legumes.

| Legume Species ¹ | Type ² | Forage value ³ | Nodule | | |
|--|-------------------|---------------------------|------------------------|------------|-----------|
| | | | Frequency ⁴ | Color | Shape |
| Mimosoideae | | | | | |
| Acacieae | | | | | |
| <i>Acacia albida</i> Del. | TC | * | + | Brown | Elongated |
| <i>A. farnesiana</i> (L.) Willd. | TC | * | + | Brown | Elongated |
| <i>A. leucophloea</i> (Roxb.) Willd. | TC | * | + | Brown | Elongated |
| <i>A. nilotica</i> (L.) Del. | TC | ** | + | Dark brown | Elongated |
| <i>A. senegal</i> (L.) Willd. | TW | ** | + | Brown | Elongated |
| Ingeae | | | | | |
| <i>Albizia julibrassin</i> Durazz. | TC | * | + | Brown | Globose |
| <i>A. lebeck</i> (L.) Benth. | TC | * | + | Brown | Globose |
| <i>A. lophantha</i> Willd. | TC | * | + | Brown | Elongated |
| <i>Pithecellobium dulce</i> (Roxb.) Benth. | TC | * | + | Brown | Elongated |
| Mimoseae | | | | | |
| <i>Leucaena leucocephala</i> (Lam.) de Wit | TC | *** | +++ | Pink | Elongated |
| <i>Prosopis cineraria</i> (L.) Druce | TC | * | + | Pink | Globose |
| <i>P. glandulosa</i> Torr. | TW | * | + | Pink | Globose |
| <i>P. juliflora</i> (Swartz) DC. | TW | * | + | Pink | Globose |
| <i>P. farcta</i> (Banks & Sol.) Macbride | TW | * | + | Brown | Globose |
| <i>Faidherbia albida</i> Del. | TC | * | + | Dark brown | Elongated |
| CAESALPINIOIDEAE | | | | | |
| Cercideae | | | | | |
| <i>Bauhinia purpurea</i> L. | TC | * | - | - | - |
| <i>B. racemosa</i> Lam. | TC | * | - | - | - |
| <i>B. variegata</i> L. | TC | * | - | - | - |
| PAPILIONOIDEAE | | | | | |
| Aeschynomeneae | | | | | |
| <i>Arachis hypogaea</i> L. | HC | *** | +++ | Pink | Globose |

| | | | | | |
|---|-----|-----|-----|--------------|--------------|
| Cicereae | | | | | |
| <i>Cicer arietinum</i> L. | HC | *** | ++ | Pink | Elongated |
| Indigofereae | | | | | |
| <i>Cyamopsis tetragonoloba</i> (L.) Taub. | SC | *** | ++ | Light pink | Semi-globose |
| Loteae | | | | | |
| <i>Lotus corniculatus</i> L. | HW | *** | +++ | Pink | Elongated |
| Phaseoleae | | | | | |
| <i>Cajanus cajan</i> (L.) Millsp. | STC | * | ++ | Light pink | Elongated |
| <i>Glycine max</i> (L.) Merr. | HC | * | +++ | Whitish pink | Globose |
| <i>Lablab purpureus</i> (L.) Sweet | HC | * | +++ | Pink | Globose |
| <i>Macropitilium atropurpureum</i> (DC.) Urb. | HC | * | +++ | Whitish pink | Globose |
| <i>M. lathyroides</i> (L.) Urb. | HC | * | ++ | White | Semi-globose |
| <i>Phaseolus coccineus</i> L. | HC | * | +++ | White | Semi-globose |
| <i>P. lunatus</i> L. | HC | * | ++ | Whitish pink | Globose |
| <i>P. vulgaris</i> L. | HC | * | +++ | Whitish pink | Globose |
| <i>Vigna aconitifolia</i> (Jacq.) Marechal. | HC | * | ++ | Pink | Globose |
| <i>V. mungo</i> (L.) Hepper | HC | * | +++ | Pink | Globose |
| <i>V. radiata</i> (L.) Wilczek. | HC | * | ++ | Pink | Globose |
| <i>V. unguiculata</i> (L.) Walp. | HC | *** | +++ | Pink | Globose |
| Robinieae | | | | | |
| <i>Robinia pseudo-acacia</i> L. | STC | *** | + | Pink | Elongated |
| <i>Sesbania bispinosa</i> (Jacq.) | STC | *** | + | Pink | Globose |
| <i>S. concolor</i> Geillett | STC | *** | + | Pink | Globose |
| <i>S. grandiflora</i> (L.) Poir. | STC | *** | + | Pink | Globose |
| <i>S. sesban</i> (L.) Merrill | STC | *** | + | Pink | Globose |
| Trifolieae | | | | | |
| <i>Medicago aculeata</i> Willd. | HI | *** | + | Pink | Elongated |
| <i>Medicago arabica</i> (L.) Huds. | HI | *** | ++ | Pink | Elongated |
| <i>Medicago blanchiana</i> Boiss. | HI | *** | ++ | Pink | Elongated |
| <i>Medicago disciformis</i> DC. | HI | *** | +++ | Pink | Elongated |
| <i>Medicago falcata</i> L. | HW | *** | ++ | Pink | Elongated |
| <i>Medicago globosa</i> Presl. | HI | *** | + | Pink | Elongated |
| <i>Medicago intertexta</i> Mill. | HI | *** | ++ | Pink | Elongated |

| | | | | | |
|--|----|------|-----|------|-----------|
| <i>Medicago litoralis</i> Lois. | HI | *** | +++ | Pink | Elongated |
| <i>Medicago lupulina</i> L. | HW | ** | +++ | Pink | Elongated |
| <i>Medicago murex</i> Willd. | HI | * | +++ | Pink | Elongated |
| <i>Medicago orbicularis</i> (L.) Bartal. | HW | * | ++ | Pink | Elongated |
| <i>Medicago polymorpha</i> L. | HC | * | ++ | Pink | Elongated |
| <i>Medicago reticulata</i> Benth. | HI | * | ++ | Pink | Elongated |
| <i>Medicago rigidula</i> (L.) All. | HI | * | ++ | Pink | Elongated |
| <i>Medicago rotata</i> Bois. | HI | * | +++ | Pink | Elongated |
| <i>Medicago rugosa</i> Desr. | HI | * | +++ | Pink | Elongated |
| <i>Medicago sativa</i> L. | HC | * | +++ | Pink | Elongated |
| <i>Medicago scutellata</i> (L.) Mill. | HI | * | +++ | Pink | Elongated |
| <i>Medicago tornata</i> (L.) Mill. | HI | * | +++ | Pink | Elongated |
| <i>Medicago truncatula</i> Gaert. | HI | * | +++ | Pink | Elongated |
| <i>Medicago tribuloides</i> Desr. | HI | * | ++ | Pink | Elongated |
| <i>Medicago turbinata</i> (L.) All. | HI | * | +++ | Pink | Elongated |
| <i>Melilotus alba</i> Medik. | HW | * | +++ | Pink | Elongated |
| <i>Melilotus indica</i> (L.) All. | HW | * | +++ | Pink | Elongated |
| <i>Trifolium alexandrianum</i> L. | HC | *** | +++ | Pink | Elongated |
| <i>T. albopurpureum</i> Torr. & A. Gray | HW | ? | ++ | Pink | Elongated |
| <i>T. alpestre</i> L. | HI | * | + | Pink | Elongated |
| <i>T. barbigerum</i> Torr. | HW | ? | ++ | Pink | Elongated |
| <i>T. bifidum</i> Gray | HW | ? | ++ | Pink | Elongated |
| <i>T. campestre</i> Schreb. | HW | ? | ++ | Pink | Elongated |
| <i>T. ciliolatum</i> Benth. | HW | ? | ++ | Pink | Elongated |
| <i>T. cyathiferum</i> Lindl. | HW | ? | + | Pink | Elongated |
| <i>T. depauperatum</i> Desv. | HW | ? | ++ | Pink | Elongated |
| <i>T. dubium</i> Sibth. | HW | ? | + | Pink | Elongated |
| <i>T. fragiferum</i> L. | HC | ** | ++ | Pink | Elongated |
| <i>T. fucatum</i> Lindl. | HW | ? | + | Pink | Elongated |
| <i>T. gracilentum</i> Torr. & A. Gray | HW | * | + | Pink | Elongated |
| <i>T. hirsutum</i> All. | HC | ** | ++ | Pink | Elongated |
| <i>T. incarnatum</i> L. | HI | * | ++ | Pink | Elongated |
| <i>T. microcephalum</i> Pursh | HW | ? | + | Pink | Elongated |
| <i>T. microdon</i> Hook. & Arn. | HW | ? | + | Pink | Elongated |
| <i>T. pauciflorum</i> Nutt. | HW | ? | + | Pink | Elongated |
| <i>T. pratense</i> L. | HC | *** | +++ | Pink | Elongated |
| <i>T. repens</i> L. | HC | *** | +++ | Pink | Elongated |
| <i>T. resupinatum</i> L. | HW | * | +++ | Pink | Elongated |
| <i>T. subterraneum</i> L. | HC | ** * | +++ | Pink | Elongated |
| <i>T. variegatum</i> Nutt. | HW | * | ++ | Pink | Elongated |
| <i>T. willdenovii</i> Spreng. | HW | ? | + | Pink | Elongated |
| | | | | | |
| | | | | | |

| Vicieae | | | | | |
|----------------------------------|----|-----|-----|------|-----------|
| <i>Lathyrus sativus</i> L. | VC | ** | ++ | Pink | Elongated |
| <i>Lens culinaris</i> Medik. | HC | ** | +++ | Pink | Elongated |
| <i>Vicia faba</i> L. | HC | *** | +++ | Pink | Elongated |
| <i>V. hirsuta</i> (L.) S.F. Gray | HW | * | +++ | Pink | Elongated |
| <i>V. sativa</i> L. | HW | * | ++ | Pink | Elongated |
| <i>V. villosa</i> Roth. | HW | * | ++ | Pink | Elongated |

¹Species are arranged alphabetically within genera.

²Legume type: H = herb; S = shrub; T = tree; V = vine or climber; C = cultivated; W = wild; I = introduced

³Forage value (Empirical scale of Brewbaker 1985).

*** Excellent; fodder species of wide and high value.

** Good; species that are used and deserve research.

* Fair; species that are used despite difficulties of use, quality, and management.

? Forage value questionable or not known.

⁴Nodulating status.

- Indicates no nodules.

+ Indicates 1 to 5 nodules per plant.

++ Indicates 6 to 10 nodules per plant.

+++ Indicates more than 10 nodules per plant.

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FLORISTICS OF BEECH-HARDWOOD FOREST IN EAST TEXAS

B.R. MacRoberts & M.H. MacRoberts

Bog Research, 740 Columbia, Shreveport, Louisiana 71104 U.S.A.

and

Herbarium, Museum of Life Sciences, Louisiana State University in Shreveport,
Shreveport, Louisiana 71115 U.S.A.

ABSTRACT

We studied the floristics and edaphic conditions of Beech-Hardwood Forest in southeastern Texas. While probably rare in presettlement times, the community is now very rare and fragmented due largely to farming and agroforestry. Much of it is degraded and only a few good examples remain.

KEY WORDS: Beech-Hardwood Forest, Sabine National Forest, floristics, Texas

INTRODUCTION

There have been numbers of studies devoted to the woody vegetation of the West Gulf Coastal Plain (WGCP) forests (Christensen 1988; Harcombe, *et al.* 1993; Harcombe & Marks 1977; Marks & Harcombe 1981; Nixon, *et al.* 1980, 1987; Nixon & Cunningham 1985; Ware, *et al.* 1993), but there have been almost none devoted to the herbaceous vegetation (Ajilvsgi 1979; Bridges & Orzell 1989a, 1989b; Harcombe, *et al.* 1993; Kral 1966). There are several reasons for this, not the least being that it is much more time-consuming to inventory the herbaceous layer.

In this paper, we describe the floristics of Beech-Hardwood Forest in the WGCP, with special emphasis on the herbaceous vegetation.

What we term Beech-Hardwood Forest is more technically referred to as American Beech-White Oak (*Fagus grandifolia-Quercus alba*) Series, which is distinguished from the American Beech-Southern Magnolia (*Fagus grandifolia-Magnolia grandiflora*) Series, the major difference being the presence of *Magnolia grandiflora* as a co-dominant in one and its virtual absence from the other (Diamond, *et al.* 1987;

Grace 1993). However, such distinctions are not always met with in the field and, in the present case, from the descriptions it appears that the two communities may not be clearly distinguishable. Consequently, we will simply call the community Beech-Hardwood Forest.

East Texas is the southwestern limit of the once extensive eastern Beech-Hardwood Forest (Logan 1959; McLeod 1972, 1975; Watson 1979). In Texas, this community is limited to mesic, sheltered (protected) ravines where ground water is nearby, usually in the form of a small creek or perennial stream. Beech is a good indicator species, but it is always accompanied by a rich array of other hardwoods (Nixon, *et al.* 1980). Beech may be declining along the southwestern border of its range as suitable protected habitat is fragmented (Logan 1959).

In Texas, Beech-Hardwood Forest is considered to be a threatened community, meaning that there are very few good examples of it remaining (Orzell 1990; Texas Organization for Endangered Species 1992; Texas Natural Heritage Program 1993).

Beech-Hardwood Forest in southeast Texas is found in ravines. The ravines in our study area are V-shaped, in the range of 30 meters deep, and have fairly steep slopes, generally about 20° to 45°, but often locally steeper. They usually lack terraces near the stream bank but may have them higher up.

At ground level, Beech-Hardwood Forest is open, with almost no shrub or midstory layer, but often with a heavy leaf litter. The upper canopy is high above the ground and shades out most light, at least in the growing season. Gaps created by tree fall often result in spectacular herbaceous growth.

One of the interesting things about the herbaceous layer of this community is the seemingly erratic nature of species occurrence. The rich northeastern vernal forb flora associated with Beech-Hardwood Forest is highly localized (Kral 1966); a day of tramping through likely habitat often yields nothing but then, one suddenly comes upon a "northern" woodland with several species such as *Sanguinaria canadensis* L., *Erythronium rostratum* W. Wolf, *Uvularia perfoliata* L., *Silene stellata* (L.) Ait., and perhaps *Cypripedium kentuckiense*. The refugium-like occurrence of these isolated populations cannot be missed (Delcourt & Delcourt 1984; Kral 1966; Webb 1981).

STUDY SITES/METHODS

In 1995 and 1996, we conducted a systematic study of Beech-Hardwood Forest on the Sabine National Forest, Texas. This consisted of an in-depth study of one site and brief surveys of others. The detailed floristic study was done on a 3 ha. site near Sulphur Creek (north of Milam) from February 1996 to November 1996. We visited the site every three weeks.

The Sulphur Creek site is divided by a narrow, perennial, west flowing creek. The study site was a north facing slope (ca. 30°) with extensive rock exposures. We collected and identified all vascular plants encountered.

The dominant trees appeared to be mature to old growth, and although some nearby ravines had old stumps, we believe that cutting in these areas, if it had occurred at all, had been selective, probably the pines. DBH measurements of some of the largest trees at the site showed they clearly fall into the size range of old growth and mature trees (Nixon, *et al.* 1980) (Table 1).

Table 1. DBH of larger trees in Sulphur Creek study site (in cm).

| Species | No. trees measured | DBH | |
|--------------------------------|--------------------|------|---------|
| | | mean | range |
| <i>Carya</i> sp. | 3 | 53 | (41-58) |
| <i>Fagus grandifolia</i> Ehrh. | 14 | 63 | (41-86) |
| <i>Fraxinus americana</i> L. | 2 | 58 | (51-66) |
| <i>Pinus taeda</i> L. | 2 | 64 | (61-69) |
| <i>Quercus alba</i> L. | 4 | 58 | (48-66) |
| <i>Q. falcata</i> Michx. | 1 | 56 | - |
| <i>Q. michauxii</i> Nutt. | 2 | 48 | (46-51) |

Since there is a major light gradient between canopy and ground, we measured light (using a Weston light meter) in Sulphur Creek to get some idea of the extremes of this gradient. On a clear day in July at noon in a gap (direct sunlight), the light measured "20"; whereas in the shade away from the gap, it measured "13." This means that there is less than five percent of the light on the ground in a closed canopy Beech-Hardwood Forest than there is in direct sun. Since the majority of trees in this habitat are deciduous, in the winter the canopy is open. The canopy closes in March and April.

Using topographic maps, we located and surveyed ravines throughout the Sabine National Forest to gather information on abundance, flora, and condition of Beech-Hardwood Forest (see also Orzell 1990).

We follow Kartesz (1994) in most instances of botanical nomenclature. Voucher specimens of many of the species collected are distributed among ASTC, BRCH, LSUS, TEX, and VDB.

While the specific fire history of Sulphur Creek is not known, we found no fire scars, and the leaf litter is deep, suggesting that it had been a very long time since the area has burnt. What the fire regime would have been under natural conditions is not known. The surrounding longleaf pine forest probably burned regularly and slow moving meandering cool ground fires probably regularly entered the ravines in presettlement times, but today, fire is suppressed.

For East Texas, precipitation is generally uniformly distributed throughout the year, averaging about 100 cm. Summers are long and hot; temperatures rise to 35° C, which, combined with short droughts, translates into dry conditions with streams sometimes drying up. Humidity is always high. Winters are mild with very few days of freezing weather (Grace 1993; Nixon, *et al.* 1980; Nixon & Cunningham 1985).

RESULTS

Table 2 lists the vascular plants found in Sulphur Creek.

Table 2. Plants of Sulphur Creek.

ACANTHACEAE - *Yeatesia viridiflora* (Nees) Small

ACERACEAE - *Acer barbatum* Michx., *A. rubrum* L.

ANACARDIACEAE - *Toxicodendron radicans* (L.) Kuntze

ANNONACEAE - *Asimina triloba* (L.) Dunal

APIACEAE - *Sanicula gregaria* Bickn.

AQUIFOLIACEAE - *Ilex longipes* Chapman ex Trel., *I. opaca* Ait., *I. vomitoria* Ait.

ARACEAE - *Arisaema dracontium* (L.) Schott, *A. triphyllum* (L.) Schott

ARALIACEAE - *Aralia spinosa* L.

ARISTOLOCHIACEAE - *Aristolochia reticulata* Jacq., *A. serpentaria* L.

ASCLEPIADACEAE - *Asclepias variegata* L.

ASPENIACEAE - *Asplenium platyneuron* (L.) B.S.P.

ASTERACEAE - *Aster lateriflorus* L., *Elephantopus tomentosus* L., *Hieracium gronovii* L., *Lactuca floridana* (L.) Gaertn., *Senecio obovatus* Muhl. ex Willd., *Solidago auriculata* Schuttlw. ex Blake, *Solidago caesia* L.

BERBERIDACEAE - *Podophyllum peltatum* L.

BETULACEAE - *Carpinus caroliniana* Walt., *Ostrya virginiana* (P. Mill.) Koch

BLECHNACEAE - *Woodwardia areolata* (L.) T. Moore

BORAGINACEAE - *Cynoglossum virginianum* L., *Lithospermum tuberosum* Rugel.
ex DC.

BRASSICACEAE - *Dentaria laciniata* Muhl. ex Willd.

CAPRIFOLIACEAE - *Lonicera japonica* Thunb., *L. sempervirens* L., *Viburnum acerifolium* L., *V. dentatum* L., *V. rufidulum* Raf.

CARYOPHYLLACEAE - *Silene stellata* (L.) Ait.

CELASTRACEAE - *Euonymus americana* L.

CLUSIACEAE - *Hypericum frondosum* Michx.

COMMELINACEAE - *Tradescantia hirsutiflora* Bush

CORNACEAE - *Cornus florida* L.

CYPERACEAE - *Carex albicans* Willd. ex Spreng., *C. amphibola* Steud., *C. blanda* Dewey, *C. debilis* Michx., *C. digitalis* Willd., *C. rosea* Schkuhr. ex Willd., *C. striatula* Michx.

DIOSCOREACEAE - *Dioscorea villosa* L.

DRYOPTERIDACEAE - *Athyrium filix-femina* (L.) Roth, *Polystichum acrostichoides* (Michx.) Schott

ERICACEAE - *Monotropa uniflora* L., *Vaccinium elliottii* Chapman

EUPHORBIACEAE - *Euphorbia corollata* L., *Sebastiania fruticosa* (Bartr.) Fern.

FABACEAE - *Cercis canadensis* L., *Desmodium nudiflorum* (L.) DC.

FAGACEAE - *Fagus grandifolia* Ehrh., *Quercus alba* L., *Q. falcata* Michx., *Q. michauxii* Nutt., *Q. phellos* L.

HAMMAMELIDACEAE - *Hammamelis virginiana* L.

HIPPOCASTANACEAE - *Aesculus pavia* L.

IRIDACEAE - *Sisyrinchium albidum* Raf.

JUGLANDACEAE - *Carya alba* (L.) Nutt. ex Ell.

JUNCACEAE - *Juncus effusus* L., *Luzula echinata* (Small) Herm.

LAMIACEAE - *Salvia lyrata* L., *Scutellaria elliptica* Muhl. ex Spreng.

LILIACEAE - *Erythronium rostratum* W. Wolf, *Smilax glauca* Walt., *S. pumila* Walt., *S. smallii* Morong, *Trillium gracile* J.D. Freeman, *Uvularia perfoliata* L.

LOGANIACEAE - *Spigelia marilandica* (L.) L.

MAGNOLIACEAE - *Magnolia grandiflora* L.

MORACEAE - *Morus rubra* L.

NYSSACEAE - *Nyssa sylvatica* Marsh.

OLEACEAE - *Fraxinus americana* L.

OPHIOGLOSSACEAE - *Botrychium bitematum* (Sav.) Underwood, *B. virginianum* (L.) Sw.

ORCHIDACEAE - *Listera australis* Lindl., *Tipularia discolor* (Pursh) Nutt.

OROBANCHACEAE - *Epifagus virginiana* (L.) W. Bart.

PAPAVERACEAE - *Sanguinaria canadensis* L.

PASSIFLORACEAE - *Passiflora lutea* L.

PHRYMACEAE - *Phryma leptostachya* L.

PINACEAE - *Pinus echinata* P. Mill., *P. taeda* L.

PLATANACEAE - *Platanus occidentalis* L.

POACEAE - *Arundinaria gigantea* (Walt.) Muhl., *Brachyelytrum erectum* (Schreb. ex Spreng.) Beauv., *Chasmanthium sessilifolium* (Poir.) Yates, *Dichanthelium boscii* (Poir.) Gould & Clark, *D. scoparium* (Lam.) Gould, *Melica mutica* Walt.

POLEMONIACEAE - *Phlox divaricata* L.

POLYPODIACEAE - *Polypodium polypodioides* (L.) Walt.

PORTULACACEAE - *Claytonia virginica* L.

RHAMNACEAE - *Berchemia scandens* (Hill) K. Koch, *Rhamnus caroliniana* Walt.

ROSACEAE - *Agrimonia microcarpa* Wallr., *Crataegus marshallii* Egglest., *C. spathulata* Michx., *Geum canadense* Jacq.

RUBIACEAE - *Galium aparine* L., *G. circaezans* Michx., *Mitchella repens* L.

STYRACACEAE - *Styrax grandifolius* Ait.

THELYPTERIDACEAE - *Phegopteris hexagonoptera* (Michx.) Fee

TILIACEAE - *Tilia americana* L.

VERBENACEAE - *Callicarpa americana* L.

VIOLACEAE - *Viola palmata* L. var. *triloba* (Schwein.) Gingins ex DC., *V. langloisii* Greene, *V. walteri* House

VITACEAE - *Parthenocissus quinquefolia* (L.) Planch., *Vitis mustangensis* Buckl., *V. riparia* Michx., *V. rotundifolia* Michx.

There were 120 species, 91 genera, and 63 families in the Sulphur Creek site, making it as species rich as many other WGCP communities. *e.g.*, bogs (Nixon & Ward 1986).

Table 3 gives information on two soil samples from Sulphur Creek (see also Nixon, *et al.* 1980).

Table 3. Soil chemistry of Sulphur Creek.

| Sample | pH | Exchangeable Ions (ppm) | | | | OM% |
|--------|-----|-------------------------|-----|-----|-----|-----|
| | | P | K | Ca | Mg | |
| Sul 1 | 5.6 | 3 | 100 | 660 | 144 | 2.8 |
| Sul 2 | 5.3 | 6 | 71 | 220 | 64 | 4.1 |

SURVEY

We surveyed ravines over the extent of the Sabine National Forest. Our survey was by no means random, but was aimed at locating high quality habitat and rare species; using topographic maps we selected the steepest sites for initial inspection. We did not repeat earlier surveys (Orzell 1990). These surveys convinced us that the deeper and steeper ravines harbor the best examples of Beech-Hardwood Forest and have the greatest variety of rare species: *Brachyelytrum erectum*, *Dentaria laciniata*, *Cypripedium kentuckiense*, *Erythronium rostratum*, *Lilium michauxii* Poir., *Sanguinaria canadensis*, *Solidago auriculata*, *Thaspium trifoliatum*, *Trillium gracile*, and *Uvularia perfoliata*.

The highest quality ravines occur in a band through the center of the Sabine National Forest, running NW to SE. They parallel the Shelby-San Augustine county line where it dips southeast at its eastern edge northwest of San Augustine and runs just north of Geneva and Milam. Kral (1966) located many northern woodland herbs in the tributaries of the Palo Gaucho Bayou area east of San Augustine. Other rich areas include the ravines east of Ragtown, near Toledo Bend Reservoir, and the ravines south of East Hamilton, again on the Toledo Bend Reservoir (Orzell 1990).

The reasons for this distribution seem to be fairly obvious. These are the deepest and steepest ravines on the Forest and thus are the most protected. Many may have never been logged, and certainly logging was seldom as extensive here as in the pine-dominated uplands.

In 1993 and 1994, we surveyed some ravines in the Kisatchie National Forest, Louisiana. Many of these had Beech-Hardwood Forest similar to that found in Texas. Rare species encountered in them include *Corallorhiza wisteriana* Conrad, *Cypripedium kentuckiense*, *Erythronium rostratum*, *Hexalectris spicata* (Walt.) Barnh., *Hydrangea quercifolia* Bartr., *Lilium michauxii*, *Monotropa hypopithys* L., *Obolaria virginica* L., *Solidago auriculata*, *Triphora trianthophora* (Sw.) Rydb., *Trillium gracile*, and *Uvularia perfoliata* (MacRoberts & MacRoberts 1995).

DISCUSSION

Kral (1966) surveyed many ravines in east Texas and northern Louisiana. He was struck by the presence of what he called "northern woodland elements" south of their normal range and speculated on their occurrence in this area. He commented on the fact that the species appeared to be clones rather than dispersed populations. Apparently most of the rare species were not reproducing sexually, but primarily vegetatively, perhaps even more so than normally occurs in many of these species (Whigham 1974). Kral was struck by the size and infrequency of the populations: walk in ravines for miles without finding anything, then a large patch of *Erythronium rostratum* or *Sanguinaria canadensis*. He proposed a refugium explanation for their occurrence; that is, these populations are probably Ice Age holdovers hanging on precariously to the older geologic terraces in the coolest locations in the forest. Reproduction, certainly by sexual outcrossing, has probably ceased, and plants spread by vegetative means.

The pattern Kral describes clearly fits what we have found, with the possible addition that at a few sites, several rare species occur together. This is the case at Sulphur Spring where *Brachyelytrum erectum*, *Sanguinaria canadensis*, *Dentaria laciniata*, *Trillium gracile*, *Erythronium rostratum*, and *Uvularia perfoliata* either occur together or in close proximity.

Kral (pers. comm.) makes the interesting suggestion that these northern species may be holding on in ravines that have not only cold-air drainage down them, but have places where such air pools, and it is in these areas, if still forested, that provide spots favorable to their continuance.

One very important thing that should be mentioned about Beech-Hardwood Forest, one that is particularly significant for its management, and this is light levels. The herbaceous layer is adapted to low levels of light and early timing of growth and flowering. For example, *Uvularia perfoliata* blooms before closure of the forest canopy (Whigham 1974). Further, and singularly important for management, is that changing light intensities by opening up the canopy lead to the rapid demise of such species as *Uvularia*. "If the over-head canopy was completely removed, it is doubtful

that any population would survive for more than a few years" (Whigham 1974:357). Maintaining the canopy and the integrity of the natural, low light levels is absolutely necessary to the survival of the herbaceous species in this community. This means more than the preservation of trees directly above, but also of those on the upper slopes, which are often pines, that contribute to reducing light levels downslope.

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NOMENCLATURAL AND TAXONOMIC NOTES ON COSTA RICAN ARACEAE

Michael H. Grayum

Missouri Botanical Garden, P.O. Box 299, St. Louis, Missouri 63166 U.S.A.

ABSTRACT

Twelve new species and two new subspecies of Araceae are described from Costa Rica: *Anthurium clidemioides* Standl. subsp. *pacificum* Croat & Grayum, *A. limonense* Grayum, *A. obtusum* (Engl.) Grayum subsp. *puntarenense* Grayum, *Homalomena hammelii* Croat & Grayum, *Monstera buseyi* Croat & Grayum, *M. filamentosa* Croat & Grayum, *M. glaucescens* Croat & Grayum, *M. lentii* Croat & Grayum, *M. molinae* Grayum, *Stenospermation majus* Grayum, *Stenospermation pteropus* Grayum, *Syngonium castroi* Grayum, *Syngonium rayi* Croat & Grayum, and *Xanthosoma dealbatum* Grayum. *Anthurium trinerve* Miq. var. *obtusum* Engl. and *Spathiphyllum wendlandii* Schott subsp. *montanum* R.A. Baker are elevated to species rank as *A. obtusum* (Engl.) Grayum and *S. montanum* (R.A. Baker) Grayum, respectively. *Monstera dilacerata* (K. Koch & Sello) K. Koch, a well-known name (though never consistently applied to any particular species), is here relegated to synonymy under *Epipremnum pinnatum* (L.) Engl. *Monstera pinnatipartita* Schott, the oldest name attributable to any species previously known as *M. dilacerata*, is neotypified accordingly.

KEY WORDS: Araceae, *Anthurium*, *Homalomena*, *Monstera*, *Spathiphyllum*, *Stenospermation*, *Syngonium*, *Xanthosoma*, Costa Rica, systematics

Field study of Araceae in Costa Rica over the past two decades has revealed numerous new taxa. Although many of these have been described in previous revisionary or floristic papers, a miscellaneous assemblage remains unnamed. The imminent publication of certain regional floristic works requires that these novelties be dealt with at the present time, together with several pertinent nomenclatural and typological problems.

ANTHURIUM

ANTHURIUM CLIDEMIOIDES Standl., Publ. Field Mus. Nat. Hist., Bot. Ser. 22:3. 1940.

This is one of just two species in *Anthurium* sect. *Polyphyllium*, unique in several attributes, including internodal roots and inaperturate, gemmate pollen (see Grayum 1990: 670). Because of its creeping habit and distant, appressed, \pm cordate, palmately veined leaf-blades, *Anthurium clidemoides* is highly distinctive within the genus, superficially resembling a *Dioscorea* or (as the epithet implies) some epiphytic Melastomataceae. It is virtually endemic to Costa Rica, known from adjacent Panamá by a single collection (Croat & Grayum 60202 [MO]) from Prov. Bocas del Toro.

Anthurium clidemoides occurs in both the Atlantic and Pacific lowlands of Costa Rica. Material from the Pacific slope differs consistently in having generally larger, proportionately narrower, less bullate and less deeply cordate leaf-blades, as well as purple (rather than green) spadices. As the type is an Atlantic slope collection, the Pacific slope entity is here described as a new subspecies.

ANTHURIUM CLIDEMIOIDES Standl. subsp. *PACIFICUM* Croat & Grayum, *subsp. nov.* TYPE: COSTA RICA. Puntarenas: Cantón de Golfito, Jiménez, Alto de Carbonera, camino a Cerro Osa, 8° 25' 30" N, 83° 19' 00" W, 200–350 m, 18 Sep 1990, A. Chacón 1062 (HOLOTYPE: MO!; Isotypes: CR!, INB!).

Subspecies haec ab subspecie nominata differt laminis foliorum majoribus proportione angustioribus minus bullatis vadius cordatis spadicebus purpuratis.

Appressed-climbing trunk epiphytes to at least 10 m above the ground; stems elongate, ca. 2–3 mm wide; cataphylls not produced. Petioles ca. 1.5–9.0 cm, \pm flattened or sulcate adaxially, rounded abaxially, the margins acute. Leaf-blades ca. 6.6–27.1 \times 3.5–12.6 cm, ovate or deltate to lance-ovate or -deltate, truncate to cordate at base, glossy or weakly velvety adaxially, weakly bullate, eglandular. Peduncles obsolete to 1.3 cm. Spathe ca. 2.1–6.8 \times 0.5–0.9 cm, oblong- to linear-lanceolate, green. Spadix ca. 2.9–9.3 cm, subsessile, purplish at anthesis. Ripe frts. orange or red.

Pacific lowlands of Costa Rica from the Reserva Biológica Carara south to the Península de Osa; 0–650+ m; January, March, June–October, December.

ADDITIONAL SPECIMENS EXAMINED. COSTA RICA. Puntarenas: Reserva Forestal Golfo Dulce, Aguabuena, Rincón de Osa, 8° 42' 20" N, 83° 31' 30" W, 50–150 m, Aguilar 227 (INB); between Rincón de Osa and Rancho Quemado, ca. 10 km W of main Rincón–Pt. Jiménez Road, 8° 41' N, 83° 32' 30" W, 150–260 m, Croat & Grayum 59773 (CR, MO [2 sheets]); Cantón de Golfito, Península de Osa, Estero Guerra de Sierpe, 8° 46' 00" N, 83° 35' 10" W, 200 m, Estrada 428 (INB); Cantón de Osa, Rincón. El Campo, Aguabuena, cuenca superior de Quebrada

Aguabuena, 8° 42' 50" N, 83° 31' 42" W, 350 m, *G. Herrera 4289* (INB,MO [2 sheets]); Cantón de Golfito, Jiménez, Alto de Carbonera, Cerro Osa, 8° 25' 30" N, 83° 19' 00" W, 326 m, *G. Herrera 4315* (CR,MO); Parque Nacional Corcovado, Sirena, Ollas Trail, 8° 27–30' N, 83° 33–38' W, 0–150 m, *Kernan 30* (CR,MO); Osa Peninsula, Corcovado National Park, 0 km to 2 km west of the park headquarters at Sirena, 0–200 m, 8° 29' N, 83° 36' W, *Liesner 2922* (MO [3 sheets]); Cantón de Osa, Rancho Quemado, Finca de Juan Marín, cerca a Guerra, 8° 44' 00" N, 83° 35' 05" W, 250 m, *Marín 95* (INB,MO); Corcovado Nat. Park, near Estación Sirena, 8° 29' N, 83° 35' W, 10 m, *Merz 559* (CR). San José: hills at SW part of Montañas Jamaica, ca. 2.5 km NE of Bijagual de Turrubares, Carara Reserve, 9° 45' N, 84° 33.5' W, 460–575 m, *Grayum, et al. 5493* (MO); Cantón de Puriscal, San Martín, falda W del Cerro Pelón, 9° 43' 40" N, 84° 23' 58" W, 650–800 m, *J.F. Morales & González 4538* (INB); Reserva Biológica Carara, Sitio Sendero Lalo Barboza, 9° 45' 40" N, 84° 31' 50" W, 300 m, *Zúñiga & Varela 290* (INB,MO).

Herrera 7807 (CR), from the Atlantic slope of Costa Rica, has leaves resembling those of *Anthurium clidemioides* subsp. *pacificum*, but green spadices as typical of subsp. *clidemioides*. The sole Panamanian collection of *A. clidemioides*, though from the Atlantic slope, resembles subsp. *pacificum* in terms of leaf dimensions and shape. Unfortunately, the specimen is sterile, so spadix color cannot be assessed.

ANTHURIUM LIMONENSE Grayum, *spec. nov.* TYPE: COSTA RICA.

Limón: Hacienda Tapezco-Hda. La Suerte, 29 air km W of Tortuguero, 10° 30' N, 83° 47' W, 40 m, 30 Aug 1979, *C. Davidson & J. Donahue 8955* (HOLOTYPE: MO-2714678!).

Inter species sectionis *Polyneurii* aspectu cum *Anthurio ravenii* Croat & R.A. Baker optime congruens, sed differt pedunculis multo brevioribus spadiceb. brevioribus purpuratisque.

Epiphytes, apparently \pm appressed-climbing; stems to at least 2.5 cm wide, with elongate roots; cataphylls thin, eventually weathering to few, fine, reddish brown fibers. Petioles ca. (17–)29–34 cm, terete. Leaf-blades ca. (22.5–)33–48 \times (11.5–)16–21 cm, simple, lance-ovate or -deltate, deeply cordate at base, eglandular. Peduncles 6.4–7.5 cm ($< 25\%$ petiole length), erect. Spathe 5.0–9.5 \times 1.2–2.5 cm, lance-oblong to \pm oblanceolate, greenish white to yellow-green. Spadix (3.5–)5.7–8.5 cm, stipitate by 2–6 mm, pinkish purple to violet. Ripe frts. unknown.

Endemic to Costa Rica, where known only from the Llanuras de San Carlos and Tortuguero on the Atlantic slope; 0–50 m; March–April, August.

ADDITIONAL SPECIMENS EXAMINED. COSTA RICA. Alajuela: 22 km NE of Quesada by air, 4 km W of Muelle San Carlos, 10° 28' N, 84° 30' W, *Liesner*

14098 (CR). Limón: Palacios, ca. 15 km WNW of Tortuguero village, on farm of Fidel Varela, 10° 28' N, 83° 38' W, ca. 5 m, *Thomsen & Korning 1309* (C).

Its very short (absolutely and relative to the petioles) peduncles immediately set *Anthurium limonense* apart from all other Costa Rican *Anthurium* species with large, cordate, eglandular leaf-blades, with the exception of the very different *A. schottianum* Croat & R.A. Baker (a member of sect. *Pachyneurium* Schott, comprising very much larger, terrestrial plants with much larger inflorescences). A few other such species (*A. obtusilobum* Schott, *A. ranchoanum* Engl.) may occasionally have peduncles as short, but always > 25% of the petiole length.

Anthurium limonense is generally most similar to a group of species mostly assigned to sect. *Polyneurium* Schott. Among Costa Rican species, the widespread and sympatric *A. ravenii* Croat & R.A. Baker [mistakenly referred to sect. *Calomystrium* Schott by Croat (1983, 1986)] bears the closest overall resemblance to *A. limonense*. However, in addition to its longer peduncles, *A. ravenii* differs in having generally longer petioles and larger leaf-blades, as well as longer spadices that are always whitish to yellowish or greenish at anthesis, rather than purplish. The label description ("violet") of the spadix coloration on the holotype of *A. limonense* is confirmed by a color slide of the living plant in the field, included in a fragment folder.¹ *Anthurium cuspidatum* Mast. (another widespread member of sect. *Polyneurium* that occurs sympatrically with *A. limonense*) also has reddish or purplish spadices, but differs in its non-cordate to shallowly cordate leaf-blades with more numerous primary lateral veins, and longer peduncles.

Another Costa Rican *Anthurium* species that may closely resemble *A. limonense* superficially is *A. obtusilobum* (sect. *Calomystrium*), which may have comparably short peduncles (in the absolute sense) in conjunction with pinkish or purplish spadices (post-anthesis). However, *A. obtusilobum* has proportionately broader leaf-blades, usually with a wider posterior sinus, that are conspicuously lineate adaxially with raphide cells (characteristic of sect. *Calomystrium*, but not evident in *A. limonense* or the other species mentioned in the foregoing paragraph). It is also restricted to somewhat higher elevations, mostly above 300 m.

I have also compared *Anthurium limonense* with a wide range of material (including many types) from outside Costa Rica, throughout the Neotropics. The only other even grossly similar species encountered during this survey were the terrestrial or epilithic, Honduran *A. lancetillense* Croat, and the montane, South American *A. sanguineum* Engl., both of sect. *Belolonchium* Schott. These species were easily eliminated on the basis of inflorescence details and other features.

The Atlantic coastal plains of Costa Rica are not noted for high endemism; indeed, most elements of this flora are widespread. Nonetheless, several species are documented as endemic to this zone, such as the highly distinctive and endangered palm *Cryosophila cookii* Bartlett (Evans 1996). Perhaps the conservation status of

¹ The label of the paratype reads "Spadix light yellow-green. Inflorescence purple/pink"; I am certain this represents a confusion of terminology, frequently seen on Araceae labels, with "Spadix" intended for the spathe, in this case, and "Inflorescence" for the spadix.

Anthurium limonense is similarly precarious. It is somewhat disconcerting that this species has been collected just three times, despite intensive collecting programs in Parque Nacional Tortuguero and the adjacent Refugio Nacional de Fauna Silvestre Barra del Colorado and Estación Biológica La Selva.

ANTHURIUM TRINERVE Miq., Linnaea 17:66. 1843.

This name has been applied to a well-known, widespread species that is very similar to the even better known *Anthurium scandens* (Aubl.) Engl. The important differences between these two taxa are enumerated in various publications, e.g., Croat (1983:233). To summarize, the taxon known as *A. trinerve* is characterized (at least in Central America) by an erect spathe, a purplish spadix, and ovoid, acute fruits, while *A. scandens* has a reflexed spathe, a whitish to greenish spadix, and subglobose, rounded fruits.

The problem regarding *Anthurium trinerve* has both nomenclatural and taxonomic components. According to the precepts of the most recent (Tokyo) *Code* (Greuter, *et al.* 1994), *A. trinerve* Miq. (1843) is an illegitimate name because it is preoccupied by *A. trinervium* Kunth (*Enum. pl.* 3:76. 1841.), effectively a homonym [see Art. 53.3, especially Ex. 8, which includes *trinervis* and *trinervius* (the masculine-gender equivalents of *trinerve* and *trinervium*) among the examples of "epithets so similar that they are likely to be confused"].

What name should Mesoamerican workers use, then, for the taxon with erect spathes, purplish spadices, and acute fruits that has been generally known as *Anthurium trinerve*? My efforts to establish which of the names listed in synonymy under *A. trinerve* in recent revisions (Croat 1983, 1986) might qualify as the next available name at species rank have been fruitless. The oldest suggested synonym is *Anthurium brachyspathum* K. Koch & Bouché (*in* K. Koch, *Allg. Gartenzeitung* 25:233. 1857.); though I have not seen the type (if any exists), the protologue describes the spathe as widely spreading ("patentissima") and the spadix as greenish white, indicating that *A. brachyspathum* should be considered a synonym of *A. scandens* rather than *A. trinerve*. The only other purported synonym at species rank is *Anthurium codajasii* G.M. Barroso (*Arch. Jar. Bot. Rio de Janeiro* 15:97. 1957.) from Estado Amazonas, Brazil; but that was described as having yellow spadices and thus is also of dubious application. Moreover, *A. trinerve* has not otherwise been reported from that part of Brazil.

Conservation of *Anthurium trinerve* Miq. over *A. trinervium* Kunth might be seen as a viable option; however, it is not at all certain, from the original description and photographs of the Surinamese holotype, whether the name *A. trinerve* itself has been properly applied to Central American material. *Anthurium trinerve* remains a poorly defined taxonomic concept that may well prove to harbor several different species (in fact, as shall be seen, it includes two distinct entities in Costa Rica alone). Furthermore, *A. trinervium* Kunth, though by far the lesser known name, is currently in use for a rare Brazilian species (in sect. *Urospadix*) still regarded as distinct, and has no known synonyms. Thus it seems inadvisable, for the purpose at hand, to propose conservation for *A. trinerve* Miq.

Therefore, a new name would seem to be called for. I consider that the name *Anthurium trinerve* var. *obtusum* Engl., based on Ecuadorean material, pertains unequivocally to the species commonly called *A. trinerve* in Costa Rica. Engler (1905) agreed, referring Costa Rican collections to var. *obtusum*, while restricting the autonymic variety to South America. I herewith elevate var. *obtusum* to species rank.

ANTHURIUM OBTUSUM (Engl.) Grayum, *stat. et comb. nov.* BASIONYM: *Anthurium trinerve* Miq. var. *obtusum* Engl., Bot. Jahrb. Syst. 25:357. 1898. TYPE: ECUADOR. [Chimborazo:] Pallatanga, 8/91, Sodiro 2 (LECTOTYPE: B! [here designated]).

Two Sodiro collections, one from Pallatanga and another from Nanegal, were cited in the protologue, with neither designated as the holotype. Croat (1983, 1986) cited only the Pallatanga syntype as the "Type," but it is questionable whether this action constituted lectotypification, as he had not seen the collection and did not specify a herbarium. I have studied only the Pallatanga collection, which I here explicitly designate as the lectotype.

As mentioned above, the species now to be known as *Anthurium obtusum* comprises two discrete taxonomic entities in Costa Rica. That best corresponding with the type is confined to the Atlantic slope. Collections from the Pacific lowlands, from the Reserva Biológica Carara south to the Península de Burica, differ consistently from Atlantic slope material in having white or greenish (rather than purplish) spadices, in addition to generally narrower leaf-blades. This material agrees with *A. obtusum*, rather than *A. scandens*, in having erect spathes and acute fruits, and is here distinguished as a new subspecies of the former.

ANTHURIUM OBTUSUM (Engl.) Grayum subsp. **PUNTARENENSE** Grayum, *subsp. nov.* TYPE: COSTA RICA. San José: Cantón de Turruabares, R. B. Carara, Puesto Carara to junction of Río del Sur and Río Carara, 9° 46' 30" N, 84° 32' 00" W, 180 m, 1 Apr 1993, *M. Grayum 10398* (HOLOTYPE: MO-4570253!; Isotypes: CR!, INB!).

Subspecies haec ab subspecie nominata differt laminis foliorum plerumque angustioribus spadicebus albis viridi-albisve.

Trunk epiphytes to at least 18 m above the ground; stems ca. 3.5–72 × 0.2–0.5 cm; cataphylls weathering to persistent reticulum of reddish brown fibers. Petioles 0.8–6.0 cm, D-shaped, channeled adaxially, the margins acute. Leaf-blades 6.6–15.9 (–18.1) × 1.0–4.2 (–4.8) cm, simple, narrowly elliptical to lanceolate, ± densely black-glandular abaxially, sparingly or not evidently black-glandular adaxially. Peduncles 1.7–12.0 cm, terete. Spathe ca. 1.0–2.5 × 0.4–0.8 cm, ovate to lanceolate, erect-ascending at anthesis, white or greenish white. Spadix 1.7–3.1 cm, subsessile, white. Ripe frts. white, bluish white ("blanco-celeste"; Zamora, *et al.* 1459), or "white with a purplish cast" (Kernan & Phillips 564).

Pacific lowlands of Costa Rica from the Reserva Biológica Carara south to the Península de Burica; 0–700 m; January–August.

ADDITIONAL SPECIMENS EXAMINED. COSTA RICA. Puntarenas: Reserva Indígena Guaymí, ca. 2 km al Oeste de donde Río Pavón se junta con Río Rincón, Golfito, 8° 37' 00" N, 83° 31' 30" W, 250 m, *Aguilar 270* (CR); Cantón de Golfito, Península de Osa, cabeceras del Río Aguja, Puerto Jiménez, 8° 32' N, 83° 26' W, 300–400 m, *Aguilar 1860* (INB); Cantón de Osa, R. F. Golfo Dulce, Los Mogos, 8° 46' 20" N, 83° 22' 40" W, 200 m, *Aguilar 4125* (INB); along the interamerican Hwy., near the Buenos Aires turnoff [Valle de El General], 9° 9' N, 83° 19' W, \pm 400 m, *Burger & Mata U. 4670* (CR); about 4 miles west of Rincón de Osa, Osa Peninsula, 8° 42' N, 83° 31' W, 30 m, *Burger & Stolze 5530* (CR); Cantón de Osa, R. F. Golfo Dulce, Península de Osa, Rancho Quemado, camino a Chiquerón, 8° 43' 00" N, 83° 34' 50" W, 200–350 m, *M. M. Chavarría, et al. 425* (INB); Cantón de Golfito, P. N. Corcovado, Playa Llorona, 8° 31' 55" N, 83° 39' 10" W, 0 m, *Chinchilla 151* (INB); eastern base of Fila Barrigones, ca. 1 km S and 2 km W of Cañasas (ca. 12 km S of Rincón de Osa), 8° 34' N, 83° 25' W, 60 m, *Croat & Grayum 59803* (MO); Cantón de Golfito, P. N. Piedras Blancas, Río Bonito, 8° 41' 25" N, 83° 13' 55" W, 100 m, *Fletes, et al. 252* (INB); Reserva Forestal Golfo Dulce, Osa Peninsula, Rancho Quemado, ca. 15 km W of Rincón, along Río Riyito, 8° 42' N, 83° 33' W, 250–350 m, *Hammel, et al. 16917* (CR); Cantón de Osa, Rincón, cuenca superior de Quebrada Aguabuena, 8° 42' 50" N, 83° 31' 42" W, 350 m, *G. Herrera 3962* (INB); Golfito, Refugio de Vida Silvestre, Quebrada Negra hasta Cerro Nicuesa, 8° 41' 30" N, 83° 12' 50" W, 345 m, *G. Herrera & Rivera 7023* (CR); Golfito, Playa Cacao, cuenca media de Quebrada Nazareno, 8° 37' 40" N, 83° 11' 10" W, 100 m, *G. Herrera & Rivera 7056* (CR); region Golfito, La Gamba, near KM. 37, 8° 41' N, 83° 13' W, 50–200 m, *Huber & Weissenhofer 356* (CR); Parque Nacional Corcovado, Quebrada Danta, 8° 27–30' N, 83° 33–38' W, 10–30 m, *Kernan & Phillips 564* (CR); adjacent to Airfield, Rincón de Osa, 20–300 m, *Liesner 1804* (MO); Río Agua Buena near Airport to ca. 4 km above it, Rincón de Osa, 20–150 m, *Liesner 1997* (MO); Osa Peninsula, Corcovado National Park, hills 0 km to 2 km west of the park headquarters at Sirena, 8° 29' N, 83° 36' W, 0–200 m, *Liesner 2906* (MO); Cantón de Osa, Rancho Quemado, Estón Forestal, 8° 41' 05" N, 83° 33' 50" W, 230 m, *J. Marín 101* (CR); Península de Osa, Cantón Osa, lomas antes de bajar a Rancho Quemado, 8° 40' 50" N, 83° 32' 45" W, 250–300 m, *C.O. Morales, et al. 750* (USJ); Cantón de Osa, P. N. Corcovado, Península de Osa, unión de los Ríos Rincón y El Niño, 9° 33' 40" N, 83° 29' 58" W, 100 m, *J.F. Morales 3653* (INB); Cantón de Golfito, P. N. Corcovado, bosque Esquinas, 8° 46' N, 83° 15' W, 100 m, *Quesada & Segura 709* (INB); Cantón de Garabito, R. B. Carara, Estación Quebrada Bonita, 9° 46' 50" N, 84° 36' 00" W, 100 m, *E. Rojas 45* (CR, INB); Cantón de Osa, R. F. Golfo Dulce, Estación Esquinas, 8° 42' N, 83° 34' W, 200 m, *Segura &*

Quesada 64 (CR.INB); old Paul Allen property, NW of Piedras Blancas, 8° 49' N, 83° 17' W, 50 ft., *Webster 22065* (CR). San José: Z. P. La Cangreja, Santa Rosa de Puriscal, margenes del Río Negro, 9° 42' 50" N, 84° 23' 30" W, 400 m, *J.F. Morales 1450* (CR); Cerro Nara ["Puntarenas"], 9° 29' N, 84° 01' W, 700 m, *Zamora, et al. 1459* (MO).

Anthurium obtusum subsp. *puntarenense* may presently be considered a Costa Rican endemic, although its occurrence on the Península de Burica virtually guarantees that it will ultimately be found in Panamá. I have made a very thorough search for collections from other areas of Central and South America, but without success.

HOMALOMENA

Homalomena sect. *Curmeria* (Linden & André) Engl. comprises the relatively few (ca. 10) New World species of this large (ca. 147 spp.), mainly Indomalaysian genus. Four species of *Homalomena* are presently known from Costa Rica: *H. picturata* (Linden & André) Regel and *H. wendlandii* Schott are distinctive in having pubescent foliage and staminodia among the female flowers, while *H. erythropus* (Schott) Engl. and the species described below comprise glabrous plants lacking staminodia.

HOMALOMENA HAMMELII Croat & Grayum, *spec. nov.* TYPE: COSTA RICA. Heredia: Zona Protectora La Selva, 5 hour walk S of La Selva Biological Station, between the Ríos Peje and Guácimo, 10° 21' N, 84° 03' W, 300–400 m, 15 Mar 1985, *G.E. Schatz & N. Fetcher 1047* (HOLOTYPE: MO-3382690!; Isotypes: CR!, DUKE, WIS).

Inter species sectionis *Curmeriae* aspectu cum *Homalomena roezlii* (Mast.) Regel optime congruens, sed differt laminis foliorum non variegatis angustioribusque pedunculis spadicebusque longioribus.

Acaulescent or with erect stems to at least 40 cm tall and 2.5 cm wide. Petioles ca. 28–37 cm, glabrous. Leaf-blades 27.5–39.0 × 12.5–18.7 cm, plain green, broadly elliptic to narrowly ovate, broadly cuneate to rounded at base, glabrous, with ca. 22–31 primary lateral veins per side. Peduncle ca. 17.0–33.5 cm. Spadix (8.5–)12.6–12.9 cm.

Endemic to Costa Rica, Atlantic slope of Volcán Barva; 50–400 m; March, July.

ADDITIONAL SPECIMENS EXAMINED. COSTA RICA. Heredia: "Zona Protectora La Selva," along Quebrada Cantarrana, between Río Peje and Río Guácimo, 10° 22' N, 84° 03' W, 300–400 m, *Grayum & Jacobs 3578* (MO); Zona Protectora, northern slopes Volcán Barba, between Río Peje and Río Guácimo, along Quebrada Cantarana, 190 m, *Grayum & Schatz 3117* (MO).

CULTIVATED. Plant growing in Botany Greenhouse, Duke University [originally collected at Finca La Selva, Prov. Heredia, Costa Rica, 100 m down river from mouth of Q. El Salto], *Hammel 11429* (MO [3 sheets]).

Homalomena hammelii differs from Costa Rican material here called *H. erythropus* in having potentially erect, aerial stems, longer petioles, wider, differently shaped, plain green (rather than variegated) leaf-blades with more numerous primary lateral veins, and longer peduncles and spadices. Moreover, *H. hammelii* is known only from the Atlantic slope, while *H. erythropus* is restricted, in Costa Rica, to the Pacific lowlands.

Costa Rican material here referred to as *Homalomena erythropus* (based on a collection from Amazonian Brazil) has previously been identified as *Homalomena roezlii* (Mast.) Regel (see, e.g., Birdsey 1962), a name of dubious application typified by cultivated material introduced from Colombia. However, the protologue of *H. roezlii* (Masters 1874) describes plants with very much larger leaf-blades than *H. erythropus*, more along the lines of *H. hammelii* in this regard. Indeed, the possibility that *H. hammelii* might represent *H. roezlii* was carefully considered; but *H. roezlii* was described as having variegated (rather than plain green) leaf-blades even wider (ca. 20–40 cm) than those of *H. hammelii*, in combination with shorter peduncles (ca. 7.5–10 cm) and spadices (ca. 7.5–8.0 cm). Thus, the name *H. roezlii* is here rejected for any species known from Costa Rica, and must apply instead to some Colombian species remaining to be rediscovered.

Homalomena hammelii is effectively restricted to a single canyon on the lower Atlantic slopes of Volcán Barva, as far as is known. There, it may be locally abundant. This species was first discovered by MO botanist Barry E. Hammel (to whom it is dedicated) at the Estación Biológica La Selva, the only other known locality. However, that population was very small and possibly ephemeral, on the banks of a major river.

MONSTERA

Despite having been revised rather recently (Madison 1977), *Monstera* remains the most difficult genus taxonomically of Central American Araceae. The overall total of 22 species attributed to the genus by Madison (1977) approximately equals the total for Costa Rica alone, according to my field studies. The Costa Rican complement includes at least five new species, as described below.

MONSTERA BUSEYI Croat & Grayum, *spec. nov.* TYPE: COSTA RICA. Heredia: between Río Peje and Río Sardinalito, Atlantic slope of Volcán Barva, 10° 18.5' N, 84° 04' W, 480–520 m, 8 Apr 1986, *M.H. Grayum 6877* (HOLOTYPE: MO-3486393!; Isotypes: B,CR!).

Inter taxa sectionis *Monsterae* aspectu cum *Monstera adansonii* Schott var. *laniata* (Schott) Madison optime congruens, sed differt venis lateralibus

primariis laminarum foliorum numerosioribus inflorescentiis plerumque solitariis pedunculis plerumque longioribus.

Appressed-climbing trunk epiphytes, fertile ca. 1.5–3.0(–4.0) m above the ground. Juvenile lvs. not shingle-forming. Petioles of adult lvs. 20–60(–76) cm, verrucate-roughened especially toward base, sheathed to geniculum, the sheath erect to involute, often \pm undulate especially distally, deciduous or \pm persistent. Leaf-blades 27–60(–83) \times 11–29(–43) cm, ovate to lance-ovate or elliptical, broadly cuneate to rounded, truncate or subcordate at base, imperforate or (less frequently) perforate, marginally entire to pinnately lobed (with up to 4–5 pinnae per side), thinly coriaceous to subcoriaceous, with (12–)15–50+ primary lateral veins per side. Peduncle 12–30 cm. Spathe pale yellowish to white within. Spadix 5.5–13.5(–16.2) \times 1.0–1.6 cm. Infr. cream-yellowish.

Atlantic slope and near Continental Divide in the Cordilleras de Guanacaste, Tilarán, and Central, Costa Rica, and on the Pacific slope from the Río Grande de Tárcos S to the Península de Burica, where barely entering extreme SW Panamá; 0–1100(–1400+) m; January–July, November.

ADDITIONAL SPECIMENS EXAMINED. COSTA RICA. Alajuela: Reserva Río San Lorenzo of the University of Costa Rica, headwaters of the Río San Lorenzo below the Fila Volcán Muerto, 10° 23' N, 84° 33' W, 1000 m, *Barringer & Pérez* 3830 (CR,F [2 sheets]); Reserva Biológica Monteverde, Río Peñas Blancas, Finca de Tomás Guindon, 10° 19' N, 84° 43' W, 900 m, *Bello* 761 (INB.MO); eastern slopes of Volcán Miravalles, west of Bijagua, near the Río Zapote, 10° 44' N, 85° 5' W, ca. 600 m, *Burger, et al.* 11663 (MO); Bajos de Jamaical–Reserva de San Ramón, 700–1000 m, *I. Chacón* 1809 (CR); Finca Los Ensayos ca. 11 miles NW of Zarcero, ca. 850 m, *Croat* 43582 (MO); Cordillera de Tilarán, between San Ramón and Bajo Rodríguez, vicinity of La Balsa, 8.9 mi NW of center of San Ramón, 10° 10' 30" N, 84° 30' W, 1100 m, *Croat* 68068 (MO [3 sheets]); canyon of Río Cariblanco and W slope and summit or ridge between Río Cariblanco and Quebrada Quicuyal, SW of Cariblanco, 10° 16' N, 84° 12' W, 840–950 m, *Grayum, et al.* 6185 (MO); Monteverde Cloud Forest Res., valley of Río Peñas Blancas, Cordillera de Tilarán, 10° 18' 00" N, 84° 44' 30" W, 850–900 m, *Grayum, et al.* 10200 (INB [2 sheets]); Monteverde Reserve, Peñas Blancas river valley, Juan Cruz tract, 10° 18' N, 84° 45' W, 900–1150 m, *Haber ex Bello* C. 6158 (MO); Reserva Biológica Monteverde, valle del Río Peñas Blancas, Quebrada Celeste, 10° 20' N, 84° 43' W, 950–1000 m, *Haber & Bello* 7050 (MO); Reserva Monteverde, Poco Sol, 13 km S Fortuna, 10° 21' N, 84° 41' W, 700–900 m, *Haber & Zuchowski* 9345 (INB); Reserva Forestal de San Ramón, ca. 10 km west of Laguitos, along Río San Lorencito, 10° 18' N, 84° 34' W, 850–1100 m, *Hammel, et al.* 15257 (CR.MO [3 sheets]); Parque Rincón de La Vieja, Puesto Santa María, 10° 46' N, 85° 18' W, 900–1000 m, *G. Herrera* 1602 (CR.MO); Reserva Forestal de San Ramón, 10° 13' N, 84° 37' W, 800–1500 m, *Nilsson* 452 (CR), 456 (CR); P. Nac. Rincón de la Vieja, Quebrada Provisión, 2 Km aguas abajo

del sendero hacia Colonia Blanca, 10° 46' 50" N, 85° 17' 45" W, 820 m, *G. Rivera* 996 (INB); P. Nac. Rincón de La Vieja, Los Zanjós, Quebrada Rancho Grande, falda SE del Volcán Santa María, 10° 46' 42" N, 85° 17' 38" W, 900 m, *G. Rivera* 1126 (INB,MO); P. Nac. Rincón de la Vieja, Colonia Blanca, Quebrada Leiva, 10° 47' 39" N, 85° 16' 36" W, 1000–1300 m, *G. Rivera & Schamm* 1252 (INB). · Guanacaste: Parque Nacional Guanacaste, Estación Cacao, 10° 55' 45" N, 85° 28' 15" W, 1100 m, *U. Chavarría, et al.* 25 (CR); *C. Chávez* 315 (INB), *R. Espinoza* 17 (INB), 53 (INB), *Zumbado* 46 (INB); Río Chiquito, Tilarán, Arenal, 10° 24' N, 84° 52' W, 730 m, *Haber & Bello* 8256 (CR); Río Negro ford on south side of Lake Arenal, 10 km NNE of Santa Elena, 10° 25' N, 84° 46' W, 600–800 m, *Haber ex Bello C., et al.* 4866 (MO); Parque Nacional Guanacaste, Estación Pitilla, 11° 5' 2" N, 85° 25' 40" W, 700 m, *C. Moraga* 146 (CR). Heredia: Colonia Virgen del Socorro, 1000 m, *R.A. Chacón, et al.* 68 (CR); Zona Protectora, northern slopes Volcán Barba, between Río Peje and Río Guácimo, along Quebrada Cantarana, 300–400 m, *Grayum & Schatz* 3184 (DUKE). Puntarenas: about 5 km west of Rincón de Osa, Osa Peninsula, 8° 42' N, 83° 31' W, 50–200 m, *Burger & Liesner* 7327 (CR); about 4 miles west of Rincón de Osa, Osa Peninsula, 8° 42' N, 83° 31' W, 30 m, *Burger & Stolze* 5430 (CR [2 sheets]); hills above Palmar Norte, 100–200 m, *Croat* 35125 (F,MO); along road from Panamerican Hwy. at Piedras Blancas to Rincón (on Osa Peninsula), 3.7 mi W of Panamerican Hwy., 8° 46' N, 83° 18' W, 90–105 m, *Croat* 67647 (MO); between Rincón de Osa and Rancho Quemado (valley of Río Chocuaco), ca. 6 km W of main Rincón–Pto. Jiménez Road, 8° 41' N, 83° 31' 30" W, 40 m, *Croat & Grayum* 59744 (CR,MO [2 sheets]); along Quebrada Bonita, Carara Reserve, 9° 47' N, 84° 36' W, 35–80 m, *Grayum, et al.* 5722 (MO); along N Fork (known locally as "Quebrada Mona") of Quebrada Bonita, Carara reserve, 9° 47' N, 84° 36' W, 35–40 m, *Grayum, et al.* 7594 (MO); R. N. Fauna Silv. Golfito, W slope of Fila Gamba, ca. 0.5 km NE of jct. of Quebrada Gamba and Q. Rancho, 8° 41' 00" N, 83° 12' 30" W, 100–200 m, *Grayum, et al.* 10079 (MO); Cantón de Osa, El Campo, entre Aguabuena y Baneguitas, cuenca superior de Quebrada Banegas, 8° 42' N, 83° 32' W, 100–400 m, *G. Herrera* 4823 (INB); Golfito, Refugio de Vida Silvestre, cabeceras de la quebrada Cañaza, 8° 40' 10" N, 83° 11' 20" W, 150 m, *G. Herrera & Rivera* 7005 (CR); Parque Nacional Corcovado, Sirena, Los Patos Forest, 8° 28' N, 83° 35' W, 1–50 m, *Kernan & Phillips* 1118 (CR); adjacent to Airfield, Rincón de Osa, 20–300 m, *Liesner* 1746 (MO); above Airport, Rincón de Osa, 20–300 m, *Liesner* 2052 (MO [2 sheets]). San José: between Bajo La Hondura and Alto La Palma, 83° 59' W, 10° 2' N, 1400–1500 m, *Barringer, et al.* 4003A (CR,F [2 sheets]); SW part of Montañas Jamaica, ca. 2.5 km NE of Bijagual de Turrubares, Carara Reserve, 9° 45' N, 84° 33.5' W, 460–575 m, *Grayum, et al.* 5461 (MO [2 sheets]); western part of Montañas Jamaica, ca. 3 km NE of Bijagual de Turrubares, Carara reserve, 9° 45.5' N, 84° 33'

W, 500–600 m, *Grayum*, et al. 5840 (MO); Tarrazú, Nápoles, estribaciones al Oeste de Cerro Pito, 9° 34' 30" N, 84° 04' 35" W, 1200 m, *G. Herrera*, et al. 8785 (CR).

PANAMA. Chiriquí: Burica Peninsula, San Bartolo Límite, 20 Km west of Puerto Armuelles, 400–600 m, *Busey* 542 (MO).

Monstera buseyi is a widespread and frequently collected species within Costa Rica. The only specimen cited above that was seen by Madison (*Busey* 542) is annotated by him as *M. adansonii* Schott var. *laniata* (Schott) Madison. These taxa, both belonging to Madison's sect. *Monstera*, share verrucate-roughened petioles, parallel tertiary leaf-venation, frequently perforate leaf-blades, and smallish spadices shorter than the peduncles. *Monstera buseyi* differs in having usually reddish-brown-drying leaf-blades with more numerous primary lateral veins, and generally longer peduncles. The inflorescences of *M. buseyi* are usually solitary, whereas those of *M. adansonii* tend to be grouped. Furthermore, *M. buseyi* prefers more humid habitats than *M. adansonii*. The two taxa maintain their distinctiveness at sites where they co-occur, such as the Reserva Biológica Carara.

Monstera buseyi might also be compared with *M. costaricensis* (Engl. & K. Krause) Croat & Grayum, which also has verrucate-roughened petioles and may have similarly numerous primary lateral veins. However, *M. costaricensis* (restricted to below 100 m on the Atlantic slope) has relatively shorter petioles with the sheaths coarsely undulate throughout their length, grayish-drying leaf-blades, and relatively shorter peduncles.

This new species, virtually endemic to Costa Rica, is dedicated to Philip Busey, formerly of the Missouri Botanical Garden, who made the first collection known to us (and the only one from Panamá) on 22 Feb 1973.

MONSTERA DILACERATA (K. Koch & Sello) K. Koch, in A. Braun, et al., *Append. Gen. Sp. Hort. Berol.* 1855:5. 1855–1856. BASIONYM: *Scindapsus dilaceratus* K. Koch & Sello, in A. Braun, et al., *Append. Sp. Hort. Berol.* 1853:6. 1853–1854.

As discussed in detail by Croat & Grayum (1987), the name *Monstera dilacerata*, though well known, is ambiguously typified and, moreover, was applied in the most recent revision of the genus (Madison 1977) to at least four distinct species. As is the case with many of Koch's aroid species, *M. dilacerata* was based on sterile, cultivated material of unknown origin, and the type specimen itself is lost. The only surviving images of Koch's type are a photograph (MO-1663837!) and drawings at K made by N.E. Brown.

During the course of my recent work on *Monstera* in Costa Rica, I was unable to match the abovementioned photograph with any Costa Rican taxon, despite the fact that Engler & Krause (1908) cited mostly Costa Rican material under this name. I thereby satisfied myself that the name could be disregarded for my purposes as representing a taxon that does not occur in Costa Rica, obviating the sticky issue of the identity of the type. Croat & Grayum (1987) had sidestepped this issue by relegating *M. dilacerata* "to the limbo of nomen dubium status, where it will probably lie forever unless someone can come up with a way . . . to unequivocally interpret the type specimen, in the unlikely event that it ever turns up." Now, new information

suggesting the true identity of Koch's *Monstera dilacerata* has appeared unexpectedly. While studying *Monstera exsiccatae*, I discovered a hand-written note signed by N.E. Brown within a fragment folder affixed to *Donnell Smith 6808* (US), a Costa Rican specimen of the species here called *M. dissecta* (Schott) N.E. Br. ex Donn. Sm. (see following entry). Though Madison annotated this specimen (as *M. dilacerata*), he apparently did not find Brown's note, which is worth reproducing here in its entirety:

6808 *Tornelia dissecta*, Schott. This plant has not been published as a *Monstera*, to which genus it belongs. Engler in DC. Monog. Phan. II. 265 has quoted this plant & *Monstera parkeriana*, Schott, as synonyms of *Monstera dilacerata*, K. Koch, from both of which it is utterly distinct. As for *Monstera dilacerata* K. Koch, I am now fully persuaded that it is identical with *Epipremnum mirabile*, Schott, although I did not think so in 1882 when I published my account of that plant in the Journal of Botany. I have seen Koch's type & have drawings of it. N. E. Brown, May 1898.

My cursory perusal of MO's material of *Epipremnum pinnatum* (L.) Engl. (of which *E. mirabile* is now regarded as a synonym) confirmed a general resemblance to the photograph of Koch's *Monstera dilacerata*. I subsequently brought the matter to the attention of Peter Boyce (K), currently undertaking a treatment of *Epipremnum* and allied genera for *Flora Malesiana*. The following response from Boyce was received via e-mail, dated 10 Apr 1996:

Have found Brown's drawings of the type of the name *M. dilacerata*. They absolutely match *E. pinnatum*. For me the most important character is the presence of 'pin holes' (Brown's 'pellucid dots') along the mid-vein. This is a character, as far as I'm aware, unique to *E. pinnatum*. I'd have no hesitation in reducing *M. dilacerata* to *E. pinnatum*.

Brown's reference to "pellucid dots" is contained in the Journal of Botany article (Brown 1882) mentioned in his hand-written note. It may be assumed that Brown observed these dots, first-hand, on Koch's type specimen. Thus, the *Monstera dilacerata* problem appears finally to be resolved: the name can be buried safely in synonymy under the much older *Epipremnum pinnatum* (L.) Engl., long in use for a familiar Indomalaysian species that Koch must have had in cultivation.

Although it would be possible to maintain *Monstera dilacerata* with a conserved type, there would seem to be no point in doing so, since the name has never been used consistently for any single species. The four Costa Rican species included by Madison (1977) under *M. dilacerata* will henceforth be known by the names *M. dissecta*, *M. glaucescens* Croat & Grayum, *M. lentii* Croat & Grayum, and *M. pinnatipartita* Schott, all dealt with separately in the present paper.

MONSTERA DISSECTA (Schott) N.E. Br. ex Donn. Sm., *Enum. Pl. Guatem.* 5:88. 1899. BASIONYM: *Tornelia dissecta* Schott, *Oesterr. Bot. Z.* 8:179. 1858.

Although Croat & Grayum (1987) believed they were transferring *Tornelia dissecta* Schott to *Monstera* for the first time, the combination had already been validated long before, as indicated above. For further information, see the foregoing discussion under *Monstera dilacerata*.

MONSTERA FILAMENTOSA Croat & Grayum, *spec. nov.* TYPE: COSTA RICA. Heredia: S base of Cerros Sardinal, Chilamate de Sarapiquí (N side of Río Sarapiquí), 10° 27.5' N, 84° 04' W, 80–110, 4 Jul 1985, *M. Grayum & B. Hammel* 5539 (HOLOTYPE: MO-3446661-4!; Isotype: CR!).

Inter species sectionis *Marcgraviopsis* aspectu cum *Monstera punctulata* (Schott) Schott *ex* Engl. optime congruens, sed differt caulibus sulcatis dorsiventraliter compressisque laminis foliorum secus costam per fila laminaria perforatis inflorescentiis parvioribus spathis intus plerumque subroseis.

Appressed-climbing trunk epiphytes, fertile ca. 3.5–5.0 m above the ground, the stems \pm dorsiventrally compressed and coarsely sulcate. Juvenile lvs. shingle-forming. Petioles of adult lvs. ca. 23–61 cm, \pm smooth, sheathed to near geniculum, the sheath deciduous. Leaf-blades ca. 48–110 \times 26–56 cm, narrowly elliptical to lance-oblong, broadly cuneate to rounded or subcordate at base, perforate medially via \pm filamentous strands, \pm regularly (6–)9–15-pinnate or deeply pinnatifid [with 1(–2) primary lateral veins per pinna], thinly coriaceous to subcoriaceous. Peduncle ca. 4.5–11 cm. Spathe whitish to (usually) pinkish within. Spadix 6.1–11.0 \times 1.5–2.2 cm. Infr. color unknown.

Costa Rica (Atlantic slope of Cordilleras Central and Talamanca, Pacific slope on the Península de Osa) to extreme NW Colombia: 0–550(–700) m: January, April, July–September.

ADDITIONAL SPECIMENS EXAMINED. COSTA RICA. Heredia: between Río Peje and Río Sardinalito, Atlantic slope of Volcán Barva, 10° 18.5' N, 84° 04' W, 480–520 m, *Grayum* 6890 (CR [2 sheets].MO [2 sheets]); Zona Protectora, northern slopes Volcán Barba, between Río Peje and Río Guácimo, along Quebrada Cantarana, 300–400 m, *Grayum & Schatz* 3172 (DUKE). Limón: north end of Tortuguero National Park and near the Boca de las Lagunas de Tortuguero, 10° 34' N, 83° 32' W, 0–30 m, *Burger & Antonio* 11279 (F); Refugio Barra del Colorado, between Río Chirripocito and Río Sardina, 10° 38' N, 83° 45' W, 12 m, *Grayum* 9808 (CR,MO); between Río Pacuare and Quebrada Diablo, ca. 2.5 km E of Siquirres, 10° 06' N, 83° 29' W, 100–200 m, *Grayum, et al.* 7701 (CR); Cordillera de Talamanca, ridge separating Quebrada Cañabral from Río Barbilla, and slope leading down to the latter, 10° 02' N, 83° 26' W, 200–400 m, *Grayum, et al.* 8762 (CR,MO [2 sheets]); Parque Nacional Tortuguero, Lomas de Sierpe, 1 km al Oeste del puesto del Parque sobre el Río Sierpe, 10° 24' N, 83° 33' W, 100 m, *Robles, et al.* 2001 (CR,MO); Hamburg Finca, on the Río Reventazón below Cairo, 55 m, *Standley & Valerio* 48874 (US); Cerro Coronel, E of Laguna Danto, 10° 41' N, 83° 38' W, 20–170 m, *Stevens* 23789 (CR,MO), 24366 (CR,MO). Puntarenas: between Rincón de Osa and Rancho Quemado, ca. 10 km W of main Rincón–Pto. Jiménez Road, 8° 41' N, 83° 32' 30" W, 150–260 m, *Croat & Grayum* 59751 (CR,MO [4 sheets]); Cantón de Osa, Aguabuena, margen izquierda de Quebrada El Campo, Rincón, 8° 42' 45" N, 83° 31' 35" W, 200 m, *G. Herrera* 4352 (INB,MO).

PANAMA. Bocas del Toro: between Fortuna Dam and Chiriquí Grande, 7.3 mi N of bridge over Fortuna Dam, 3.2 mi N of Continental Divide, 8° 45' N, 82° 15' W, 700 m, *Croat & Grayum 60233* (MO [2 sheets]). Colón: Santa Rita Ridge Road, along trail at end of road to Río Indio, beginning 10.6 km from Transisthmian Highway, 3 km beyond hydrographic station, 380 m, *Croat 34337* (F,MO); Santa Rita Ridge Road, ca. 22 km from Transisthmian Highway, 9° 25' N, 79° 40' W, 500 m, *Hammel, et al. 14499* (MO [4 sheets]). Darién: headwater of Río Tuquesa, ca. 2 km air distance from Continental Divide, in vicinity of upper gold mining camp of Tyler Kittredge, *Croat 27179* (MO). San Blas: along El Llano–Cartí road, 10.5 mi from Interamerican Hwy., 9° 44' N, 78° 68' W, 550 m, *Croat 60488* (MO [5 sheets]); El Llano–Cartí Road, 14 mi N of Panamerican Highway, 9° 15' N, 79° 00' W, 300 m, *Croat 69243* (MO [2 sheets]).

COLOMBIA. Chocó: East side Serranía del Darién, approached from Acandí, near Finca Las Cascadas, 8° 30' N, 77° 20' W, 80–100 m, *Juncosa 590* (MO [3 sheets]).

Monstera filamentosa is a member of sect. *Marcgraviopsis* Madison, characterized by appressed juvenile “shingle leaves” and relatively short (compared to the spadix) peduncles. The only two specimens among those cited above seen by Madison, *Standley & Valerio 48874* and *Croat 27179* (both sterile), were identified as *M. punctulata* (Schott) Schott ex Engl. However, *M. filamentosa* differs from the latter in its ± flattened, sulcate stems, leaf-blades medially perforate via filamentous laminar strands (whence the species epithet), smaller inflorescences, and usually pale pinkish (vs. cream-yellowish) spathes. Moreover, *M. filamentosa* occurs at generally lower elevations than *M. punctulata*.

MONSTERA GLAUCESCENS Croat & Grayum, *spec. nov.* TYPE: COSTA RICA. Heredia: Estación Biológica La Selva, at confluence of Río Sarapiquí and Río Puerto Viejo, Atlantic slope, 10° 26' N, 84° 01' W, 50–75 m, 5 Nov 1988, *M. Grayum 8972* (HOLOTYPE: MO-3670954!).

Inter species sectionis *Monsterae* aspectu cum *Monstera dissecta* (Schott) N.E. Br. ex Donn. Sm. et *M. pinnatipartita* Schott optime congruens, sed differt parte petioli ultra vaginam longiore petiolis pedunculis spathis in alabastro extus glaucis.

Appressed-climbing trunk epiphytes, fertile ca. 1.0–2.5 m above the ground. Juvenile lvs. not shingle-forming. Petioles of adult lvs. ca. 14.5–41.0 cm, ± smooth, glaucous, sheathed for ca. 50–75% their total length, the sheath erect, persistent. Leaf-blades ca. 24–47 × 10.5–33.0 cm, ovate to elliptical, broadly cuneate to rounded, truncate or subcordate at base, imperforate, ± deeply pinnatifid with (2–)3–5(–8) pinnae per side, subcoriaceous to coriaceous, with 6–17 primary lateral veins per side. Peduncle ca. 10–22 cm, glaucous. Spathe white within, glaucous externally (in bud). Spadix 5–9 × 1.0–1.7 cm. Infr. white to light yellow.

Southeastern Nicaragua and Costa Rica (Atlantic slope) to E Panamá; 0–850 m; January–November.

ADDITIONAL SPECIMENS EXAMINED. NICARAGUA. Río San Juan: near Caño Chontaleno, 20 Km. N.E. of El Castillo, 200 m, *Neill & Vincelli 3489* (MO). Zelaya: Río Punta Gorda, Atlanta, "La Richard" Loma San Jorge, 11° 31' N, 84° 04' W, 150–160 m, *Moreno & Sandino 13047* (MO), *13054* (MO); Caño Costa Riquita, ca. 1.8 km SW of Colonia Naciones Unidas, S of road between Colonia Nueva León and Colonia Naciones Unidas, ca. 11° 43' N, 84° 18' W, 150–180 m, *Stevens 5030* (MO).

COSTA RICA. Alajuela: San Carlos, 3 km south of Boca de Arenal, 10° 30' N, 84° 27' W, 100 m, *Hammel & de Nevers 15320* (MO); 2 km N of Santa Rosa, 15 km N of Boca Arenal on Quesada–Muelle San Carlos–Los Chiles road, 10° 38' N, 84° 31' W, ca. 100 m, *Liesner, et al. 15034* (CR,MO [2 sheets]); Bajo Rodríguez, ca. 300 m, *Utley & Utley 4625* (MO). Heredia: entre el campamento Santa Rana y Río Peje, Magsasay, 400 m, *I.A. Chacón 70* (CR); Finca La Selva, Puerto Viejo de Sarapiquí, *I. Chacón 1132* (CR); Finca La Selva, Puerto Viejo de Sarapiquí, along El Surá trail, 100–150 m, *Croat 44322* (MO [2 sheets]); O.T.S. La Selva Reserve, 10° 26' N, 84° 01' W, *Croat 61217* (MO); north of Puerto Viejo, 10 km down road, then 7–8 km west in forest, *Garwood, et al. 848* (CR,MO); south of Puerto Viejo, 2 km south of Magsasay Penal Colony, c. 200 m, *Garwood, et al. 1111* (CR); Finca La Selva, at confluence of Río Sarapiquí and Río Puerto Viejo, 10° 26' N, 84° 01' W, 50–80 m, *Grayum 7667* (MO); Finca La Selva, the OTS Field Station on the Río Puerto Viejo just E of its junction with the Río Sarapiquí, ca. 100 m, *McDowell 222* (MO). Limón: 12 km W of Bri Bri between Suretka & the drilling platforms, ca. 200 m, *Barringer 3043* (CR [2 sheets]); Talamanca cantón, between Cahuita and the oil drilling platforms beyond Suretka, ca. 9° 35' N, 82° 55' W, 100–300 m, *Barringer, et al. 2643* (CR [2 sheets],F); Hacienda Tapezco–Hda. La Suerte, 29 air km W of Tortuguero, 10° 30' N, 83° 47' W, 40 m, *Davidson, et al. 6938* (MO); 7 Km SW of Bribri, 100–250 m, *Gómez, et al. 20372* (MO [5 sheets]); Refugio Barra del Colorado, between Río Chirripocito and Río Sardina, 10° 38' N, 83° 45' W, 12 m, *Grayum 9800* (CR,MO [2 sheets]); between Río Pacuare and Quebrada Diablo, ca. 2.5 km E of Siquirres, 10° 06' N, 83° 29' W, 100–200 m, *Grayum, et al. 7702* (CR,MO); Parque Nacional Tortuguero, Estación Agua Fría, 6–7 Km al sureste, Cerros Azules, 10° 27' N, 83° 34' W, 70 m, *Robles 1553* (CR), *1558* (CR), *1579* (CR); Parque Nacional Tortuguero, Estación Agua Fría, ca. 12 Km al Noreste, pasando el Río Pueblo Nuevo, sobre las Lomas de Sierpe, 10° 26' N, 83° 32' W, 80–100 m, *Robles 1672* (CR); Cantón de Limón, Cerro Muchilla, Fila Matama, 9° 47' 50" N, 83° 05' 30" W, 850 m, *Robles & A. Chacón 2735* (CR); Finca Montecristo, on the Río Reventazón below Cairo, ca. 25 m, *Standley & Valerio 48938* (US), *48945* (US), *49010* (US).

PANAMA. Coclé: north of El Copé, ca. 500 m, *D'Arcy 11294* (MO); vicinity El Copé, 5–6 mi N of El Copé, 8° 38' N, 8° 35' W, 600–800 m, *Croat & Zhu 77200* (CR,MO [2 sheets]). Darién: Río Balsa between Manene & Guayabo, *Duke & Nickerson 14956* (US). Panamá: road past Altos de Pacora, 3.0–3.5 mi NE of Altos

de Pacora, 7.8–8.2 mi above Pan Am Highway, 11.1–11.6 mi beyond Lago Cerro Azul, 9° 15' N, 79° 25' W, 700–750 m, *Croat 68681* (MO [2 sheets]); Cerro Jefe, .5 Km south of the summit, *Busey & Croat 260* (MO).

Monstera glaucescens, a member of Madison's sect. *Monstera*, belongs to the species complex formerly subsumed under the name "*Monstera dilacerata*"; all of the above-cited specimens seen by Madison (*Standley & Valerio 48938, 48945, 49010; Duke & Nickerson 14956*) are so determined. Within this group, *M. glaucescens* is most similar to *M. dissecta* and *M. pinnatipartita*, from both of which it differs in its glaucous parts (suggesting the specific epithet) and comparatively short petiole sheaths.

Unfortunately, these critical diagnostic characters may be difficult to assess on herbarium material. The leaf-blades of *Monstera glaucescens* dry blackish, as in *M. pinnatipartita* but unlike the sympatric *M. dissecta*.

Monstera glaucescens comprises rather short-stemmed, appressed-climbing, understory trunk epiphytes of primary forests, whereas plants of *M. dissecta* and *M. pinnatipartita* tend to be coarser, higher climbing, and weedier.

MONSTERA LENTII Croat & Grayum, *spec. nov.* TYPE: COSTA RICA. Cartago: 10 km S of Cartago by air, along confluence of Río Empalme and Río Estrella, 1 km S of Palo Verde by road, 9° 46' N, 83° 57' W, 1450 m, *Liesner & Judziewicz 14549* (HOLOTYPE: MO-3116693-4!; Isotype: RSA!).

Inter species sectionis *Monsterae* aspectu cum *Monstera pinnatipartita* Schott optime congruens, sed differt stylis conicis teretibusve projectisque stigmatibus capitatis habitatione montana.

Appressed-climbing trunk epiphytes, fertile ca. 2–3(–8) m above the ground. Juvenile lvs. not shingle-forming. Petioles of adult lvs. 21–56 cm, ± smooth, sheathed to within ca. 1–4 cm of geniculum, the sheath erect to revolute, persistent (except Panamá). Leaf-blades 24–60 × 13.5–41.0 cm, ovate to ± oblong, broadly cuneate to rounded or subcordate at base, often perforate, ± deeply pinnatifid (with 3–8 pinnae per side), subcoriaceous, with 10–14 primary lateral veins per side. Peduncle 7.5–25 cm. Spathe white to cream-yellowish within. Spadix 4.3–10 × 1.3–2.0(–3.1) cm. Infrs. white.

Costa Rica and western Panamá; 1050–1650+ m; March–September, November–December.

ADDITIONAL SPECIMENS EXAMINED. COSTA RICA. Cartago: hills above El Muñeco, along Río Sombrero, 9° 45' N, 83° 55' W, 1500 m, *Barringer & Christenson 4144* (MO [2 sheets]); Tapantí Hydroelectric Reserve trail along Río Dos Amigos, 1600–1700 m, *Croat 36192* (MO [2 sheets]); between Moravia and Quebrada Platanillo, 3–5 km from Finca Racine in Moravia, 1200–1300 m, *Croat 36615* (CR, MO); along Camino Raiz de Hule, SE of Platanillo (Tsipirí), 1200–1400 m, *Croat 36723* (MO), *36748* (MO [2 sheets]); Tapantí reserve ca. 1 km S of jct. of Quebrada

Salto and Río Grande de Orosi, 9° 43' N, 83° 47' W, 1500–1800 m, *Croat & Grayum 68291* (MO [3 sheets]); Reserva de Tapantí, 1300–1800 m, *Gómez 18772* (MO); hill just to north of Quebrada Casa Blanca, Tapantí, 9° 47' N, 83° 47.5' W, ca. 1350 m, *Grayum 3889* (MO [2 sheets]); along tributary of Quebrada Casa Blanca, Tapantí, 9° 47' N, 83° 48' W, ca. 1350 m, *Grayum & Sleeper 3696* (MO [2 sheets]); Hacienda Queverí, Río Macho de Paraíso, along road leading to Río Blanco, 9° 45' N, 83° 51' W, ca. 1630 m, *Grayum, et al. 3490* (MO [2 sheets]); Turrialba, Tayutic, Vereh, siguiendo la Fila entre Río Vereh y Río Jicotea, 9° 46' N, 83° 32' 40" W, 1500 m, *G. Herrera & Cascante 8130* (CR); hillside overlooking Río Grande de Orosi, about 3 km S.E. of Tapantí, 1400 m, *Lent 824* (US); Reserva Forestal Río Macho, 1300–1500 m, *Nilsson & Manfredi 125* (CR). Limón: Cantón de Limón, N flank of Fila de Matama in headwaters of Río Boyei, Cordillera de Talamanca, 9° 45' N, 83° 19' W, 1200–1300 m, *Grayum 11025* (INB [2 sheets], MO [2 sheets]); Cantón de Talamanca, Alto Lari, Kivut, entre las cabeceras del Río Lari y Río Dapari, 9° 23' 33" N, 83° 05' 40" W, 1550 m, *G. Herrera 5358* (MO).

PANAMA. Bocas del Toro: between Fortuna Dam and Chiriquí Grande, along gravel road which departs main hwy. near Continental Divide (4.5 mi N of bridge over Fortuna Lake), 8° 44' N, 82° 17' W, 1170 m, *Croat 66659* (MO); Fortuna Dam region, along continental divide trail bordering Chiriquí, 8° 45' 04" N, 82° 15' 04" W, 1200–1300 m, *McPherson & Aranda 10057* (MO [2 sheets]). Chiriquí: N. E. del campamento de Fortuna (Hornito), sitio de presa, 8° 45' N, 82° 15' W, 1000–1200 m, *Correa A., et al. 2465* (MO), 2688 (MO); Cerro Colorado, along road above Félix 29 km above bridge over Río San Félix (7.9 km above turnoff to Escopeta), 1500 m, *Croat 37080* (MO); vicinity of Fortuna Dam site on Río Chiriquí beyond Gualaca, 20.9 mi from bridge over Río Esti, 10.8 mi beyond Los Planes de Hornito, 1400 m, *Croat 48720* (MO); between Gualaca and Fortuna dam site, 10 mi NW of Los Planes de Hornito, 8° 45' N, 82° 17' W, 1260 m, *Croat 50077* (MO [2 sheets]); Gualaca–Chiriquí Grande Road over Fortuna Lake, along gravel road which departs main highway near Continental Divide (4.5 mi N of middle of bridge over Fortuna Lake), 8° 44' N, 81° 17' W, 1170 m, *Croat 66670* (MO); between Fortuna Lake and Chiriquí Grande, 4.5–5.0 km N of dam over Fortuna Lake, 8° 43' N, 82° 17' W, 1100–1135 m, *Croat & Grayum 59988* (MO [2 sheets]); Fortuna Dam Area, Fortuna–Chiriquí Grande, 5.3 mi N of center of Fortuna Dam, then 1.4 mi W along gravel road to Continental Divide Trail, 8° 44' N, 82° 17' W, *Croat & Zhu 76318* (MO [2 sheets]); Fortuna Dam Area, Fortuna–Chiriquí Grande, 1.8 mi NW of center of dam, 8° 45' N, 82° 18' W, 1080 m, *Croat & Zhu 76499* (MO); just west of the Fortuna camp, 1400–1600 m, *Folsom, et al. 5358* (MO); vicinity of Fortuna Dam, in valley south of lake, 8° 45' 04" N, 82° 15' 04" W, 1200–1300 m, *McPherson & Aranda 10124* (MO).

Monstera lentii, a member of Madison's sect. *Monstera*, is one of several species formerly included in "*Monstera dilacerata*"; *Lent 824*, the only specimen cited above that was seen by Madison, was so annotated. It is unique in this group (and among all other Costa Rican *Monstera* species) in its conical or terete, projecting styles with

capitate stigmas, and is also the only species in the "*Monstera dilacerata*" complex occurring above 1000 m elevation on the Atlantic slope of the Cordillera de Talamanca. The deeply pinnatifid, blackish-drying leaf-blades of *M. lentii* especially recall *M. pinnatifartita*, restricted to the Pacific lowlands in Costa Rica.

The Panamanian material cited here, mainly from the La Fortuna region, seems to have consistently deciduous petiole sheaths, and is included tentatively.

This new species is dedicated to Roy W. Lent, currently a resident of Costa Rica, who made the first collection known to us on 16 Apr 1967.

MONSTERA MOLINAE Grayum, *spec. nov.* TYPE: COSTA RICA. Guanacaste: Parque Nacional Rincón de la Vieja, the SE slopes of Volcán Santa María, above Estación Hacienda Santa María, 10° 47' N, 85° 18' W, 900–1200 m, 27–28 Jan 1983, *G. Davidse, L.D. Gómez, M. Sousa, C.J. Humphries, N. Garwood, R. Hampshire, & M. Gibby 23344* (HOLOTYPE: CR-97202!; Isotype: MO!).

Inter species sectionis *Marcgraviopsis* aspectu cum *Monstera spruceana* (Schott) Engl. optime congruens, sed differt habitibus laxius scandenti petiolis laminis foliorum spadicibus longioribus.

Epiphytic vines on tree-trunks, or ascending to canopy. Juvenile lvs. unknown, presumably shingle-forming. Petioles of adult lvs. ca. 7.5–19 cm, smooth (dry), sheathed to near base of blade, the sheath deciduous. Leaf-blades ca. 10.5–33.0 × 8–27 cm, broadly ovate to elliptical, broadly cuneate to rounded or truncate at base, imperforate, deeply pinnatifid with 2–5 pinnae on at least one side, subcoriaceous, with 4–8 primary lateral veins per side. Peduncle ca. 2.5–6.0 cm. Spathe creamy white within. Spadix 5–10 × 1.5–2.4 cm. Infr. color unknown.

Costa Rica (Atlantic slope and near Continental Divide, Cordilleras de Guanacaste, Tilarán and Central) and central Panamá; 0–1000+ m; January–March, November.

ADDITIONAL SPECIMENS EXAMINED. COSTA RICA. Alajuela: about 3 km NNE of Bijagua along the new road to Upala, 10° 45' N, 85° 3' W, 450 m, *Burger & Baker 9882* (CR); between Cañas and Upala 4 km NNE of Bijagua on slopes leading into Río Zapote, ca. 400 m, *Croat 36259* (MO [2 sheets]); entre la estación de la Reserva Forestal de San Ramón y el camino a la colonia Palmareña, margen derecha Río San Lorenzito, 10° 12' 53" N, 84° 36' 28" W, *G. Herrera Ch. 499* (MO [3 sheets]); Parque Rincón de la Vieja, Upala, siguiendo el canal hasta Quebrada Provisión y de ahí por el canal secundario hasta la quebrada siguiente, 800–900 m, *G. Herrera 1517* (CR,MO); near Los Angeles, Llanura de San Carlos, 100 m, *Molina R., et al. 17685* (NY); Cantón de Upala, P. N. Guanacaste, Cord. de Guanacaste, Estación San Ramón, Dos Ríos, 10° 52' 50" N, 85° 24' 05" W, 550 m, *F. Quesada 191* (INB). Guanacaste: Rincón de la Vieja National Park, path from Puesto Santa María to hot springs, c. 800 m, *Garwood, et al. 755* (CR,MO); El Dos de Tilarán, 4 km N, Cerro La Chirripa, Atlantic slope, 10° 25' N, 84° 50' W, 1000 m,

Haber ex Bello C. & Lierheimer 4446 (CR,MO). Heredia: entre el campamento Canta Rana y Río Peje, Magsasay, 400 m. I.A. *Chacón 82* (CR,MO); near Porto Viejo along road to Río Sucio, 20 m, *Croat 35689* (MO); Finca La Selva, Sarapiquí, *Grayum 3063* (DUKE). San José: Fila Carrillo, Parque Nacional Braulio Carrillo, 700 m, *Gómez, et al. 21131* (CR [2 sheets]).

PANAMA. Coclé: area surrounding Rivera Sawmill, 7 km north of El Copé, Forgotten Hill, 650–850 m, *Folsom 6207* (MO).

Although juvenile foliage of *Monstera molinae* is unknown, this species is undoubtedly a member of sect. *Marcgraviopsis*, on the basis of its short peduncles (relative to the spadix) and close resemblance to several other species in this group, particularly *M. luteynii* Madison, *M. pittieri* Engl., and *M. spruceana* (Schott) Engl. The first two differ from *M. molinae* in having consistently entire leaf-blades (though some Panamanian populations of *M. pittieri* may have perforate blades); plants of *M. spruceana* have a somewhat different (consistently appressed-climbing) growth habit, are larger in all their parts, and (in Costa Rica) virtually always have entire leaf-blades.

Molina R., et al. 17685, the only specimen cited above that was seen by Madison, was annotated by him as "*Monstera dubia* (H.B. & K.) Engler & Krause?"

This new species honors Antonio Molina R. (EAP), dean of Honduran botanists, who made the first collection known to me on 21 Feb 1966.

MONSTERA PINNATIPARTITA Schott, Oesterr. Bot. Wochenbl. 7:197. 1857.

TYPE: VENEZUELA. Distrito Federal: Caracas, "*Reichenb. f. comm.*" (HOLOTYPE: W?, presumably lost). Zulia: Distrito Perijá, ca. 13 airline km NE of the intersection of the Maracaibo–La Fría Hwy. (Hwy. 6) and the Río Aricuaísá (near the intersection of LAGOVEN picas 80-2 and 19), 9° 26' N, 72° 29' W, 40 m, 20 Jun 1980, *G. Davidse, A.C. González, & R.A. León 18286* (NEOTYPE: MO-2901380!, here designated; Isoneotype: VEN, *non vidi*).

Monstera pinnatipartita is an obscure name, based on a description of a sterile specimen from near Caracas. No type specimen has been found at W (repository for both Schott's and Reichenbach's material), and no illustration appears in Schott's *Icones* (Schott 1983), or anywhere else. The name was not treated at all by Engler & Krause (1908), Bunting (1979), or Croat & Lambert (1986). However, Madison (1977) included *M. pinnatipartita* in synonymy of his *M. dilacerata*, and a careful reading of the description confirms this disposition.

One of the four species of the "*Monstera dilacerata*" complex occurring in Costa Rica is characterized by involute petiole sheaths and blackish-drying leaf-blades deeply pinnatifid into usually narrow segments. For several years, we have used the unpublished name "*Monstera involuta*" for this species. "*Monstera involuta*" is restricted, in Costa Rica, to the Pacific lowlands, from the Golfo Dulce region (including Isla del Caño) north to the Nicoya Peninsula (where it occurs locally in more humid sites). According to a herbarium search at MO, the same species ranges southward to coastal Ecuador, and eastward to northern Colombia and Venezuela, always in hot, lowland regions. In Venezuela, the region of the type locality of *M. pinnatipartita*, "*M. involuta*" is the only species in the "*M. dilacerata*" complex; thus, I

have no compunction in applying Schott's forgotten name to this species, and would rather resurrect (and clarify) an existing name than publish a new one. With *Monstera dilacerata* removed to the synonymy of *Epipremnum pinnatum*, *M. pinnatipartita* becomes the oldest name in the "*M. dilacerata* complex, and therefore must be used for some species in this group regardless of taxonomy.

The specimen of "*Monstera involuta*" from nearest Caracas that I have seen is *Steyermark & Carreño E. 106897* (MO), from Estado Miranda. However, as this specimen is sterile, I instead select a good, fertile specimen from Estado Zulia to neotypify *M. pinnatipartita*. This specimen, *Davidse, et al. 18286* (MO), is represented by a total of eight duplicates, according to the field-notes of the principal collector. One of these was left at VEN, however I cannot account for the whereabouts of the other six duplicates, which were distributed under the name *Monstera dilacerata*.

SPATHIPHYLLUM

SPATHIPHYLLUM MONTANUM (R.A. Baker) Grayum, *stat. et comb. nov.*

BASIONYM: *Spathiphyllum wendlandii* Schott subsp. *montanum* R.A. Baker, in R.A. Baker & W.C. Burger, *Phytologia* 33:450. 1976.

Baker (in Baker & Burger 1976) allied this taxon with *Spathiphyllum wendlandii* largely on the basis of floral details. Baker & Burger apparently did not understand *S. wendlandii* well enough, as they neglected to mention the most distinctive feature of that taxon: the petiole sheath is horizontally splayed and extends virtually to the geniculum. Baker's subsp. *montanum* has typical petiole sheaths, more like those of *S. phryniiifolium* Schott. But even though Baker and Burger missed the important petiole character, subsp. *montanum* still comes out next to *S. phryniiifolium* (rather than *S. wendlandii*) in their key.

In truth, the relationships among these various *Spathiphyllum* taxa are not well understood, and the treatment of this taxon as a subspecies of *S. wendlandii* implies more knowledge than actually exists. An equally good case could be made for regarding it as a subspecies of *S. phryniiifolium*. Baker's "subsp. *montanum*" is a distinctive taxon, both morphologically and ecologically (it is the only montane species in Central America), and is more conveniently treated at species rank.

STENOSPERMATION

STENOSPERMATION MAJUS Grayum, *spec. nov.* TYPE: COSTA RICA. Alajuela: Reserva Forestal de San Ramón, ca. 10 km west of Laguitos, in forest on ridge and secondary woods along Río San Lorencito, 10° 18' N, 84° 34' W, 850–1100 m, 30 May–1 Jun 1986, B. Hammel, G. de Nevers, & C. Gómez 15285 (HOLOTYPE: MO-347441!).

Species insignis statura sui grandi laminis foliorum ellipticis in sicco rubescentibus spadicebus crassis floribus basalibus secus stipitem decurrentibus a speciebus mihi notis bene distincta.

Epiphytes on stumps, trunks, or occasionally in canopy (or on downfalls). Petioles 11.5–22.5(–43.5) cm, sheathed ca. 65–100% their total length. Lvs. ca. 12.5–48.0 × 5.3–17 cm, elliptical. Peduncles ca. 23–46 cm. Spathe pale green. Spadix ca. 10.7–22.5 × 1.0–1.9 cm, cream-colored, stipitate by ca. 0.5–2.2 cm. Color of ripe frts. unknown.

Atlantic slope of Cordilleras de Tilarán, Central, and Talamanca, Costa Rica; ca. 500–1200 m; February–April, June–July, November.

ADDITIONAL SPECIMENS EXAMINED. COSTA RICA. Alajuela: Reserva Monteverde, Río Peñas Blancas, 10° 18' N, 84° 44' W, 900 m, *Bello 165* (CR); Reserva Monteverde, Río Peñas Blancas, 10° 19' N, 84° 43' W, 1000 m, *Bello 522* (CR); San Carlos. Peñas Blancas, 900 m, *Haber & Bello C. 1920* (MO); Reserva Biológica Monteverde, valle del Río Peñas Blancas, Quebrada Celeste, 10° 20' N, 84° 43' W, 950–1000 m, *Haber & Bello 7067* (MO); Bosque Eterno de Los Niños, Atlantic slope, Río Peñas Blancas valley, Laguna Poco Sol, 10° 21' N, 84° 40' W, 840 m, *Haber & Zuchowski 11153* (INB,MO). Heredia: along new road to the north of Quebrada Tigre, from Finca El Plástico to ca. 1.5 km NE thereof (ca. 8 km SW of Las Horquetas), 10° 18' N, 84° 02' W, 450–550 m, *Grayum & Sleeper 6531* (CR, MO). Limón: Reserva Indígena Talamanca, entre el Río Sukut y el Río Urén, camino a Purisqui, 9° 24' 30" N, 82° 58' 10" W, 700 m, A. *Chacón 108* (CR); Parque Internac. La Amistad, Croriña, camino a Amubri, Quebrada Crori y Quebrada Lumbeta, 9° 25' 15" N, 82° 59' W, 800 m, A. *Chacón 169* (CR); cerro entre Cerro Chimú y Cerro Matama, 1200 m, *Gómez, et al. 23573* (MO).

As implied by its specific epithet, *Stenospermaton majus* is the largest of all Costa Rican *Stenospermaton* species. It is further distinguished its elliptical, reddish-brown-drying, leaf-blades and long, thick (> 1 cm) spadices with some basal flowers decurrent onto the stipe. Because of their large size, plants of this species have sometimes been misdetermined as *S. robustum* Engl.; however, despite its name, the last-mentioned species (based on a Costa Rica type) comprises smaller plants in every respect, with blackish-drying foliage and non-decurrent basal flowers. The new species more closely resembles the Panamanian "*Stenospermaton luteynii*" (Pérez de Gómez 1983); though I have not seen the proposed type of that still-unpublished name, none of the other specimens at MO so determined by Pérez de Gómez matches *S. majus* in all critical details, differing in one or more of the following characters: extent of petiolar sheathing, leaf-blade shape, thickness of the spadix, or decurrence of basal flowers on the stipe. Similarly large-leaved South American species (*Stenospermaton crassifolium* Engl., *S. maximum* Engl., *S. longifolium* Engl., *S. porteri* Sodiro) have been eliminated by these and other (color of foliage on drying) criteria.

STENOSPERMATION PTEROPUS Grayum, *spec. nov.* TYPE: COSTA RICA. Limón: Alto Urén, subiendo por la fila entre la margen derecha de la Quebrada Chaho y la margen izquierda del Río Lorni, Cerro Láubeta, 9° 23' 10" N, 83° 00' 25" W, 1190 m, 26 Jul 1989, G. Herrera 3353 (HOLOTYPE: MO-3853475!; Isotypes: CR!, K, USJ!).

Species insignis foliis suis parvis vagina petiolari horizontaliter explanata usque ad basim laminae extensa a speciebus mihi notis bene distincta.

Epiphyte. Petioles ca. 1.6–3.5 cm, sheathed to leaf-base. Leaf-blades 5.5–9.3 × 1.2–2.0 cm, lanceolate to oblong-lanceolate or narrowly elliptical. Peduncles ca. 4 cm. Color of spathe unknown. Spadix ca. 1.8–2.0 × 0.4 cm, of unknown color, spititate by ca. 0.3–0.4 cm. Color of ripe frts. unknown.

Atlantic slope of Cordillera de Talamanca, Costa Rica; ca. 1200 m; July.

Stenospermation pteropus, known only from the type collection, is the smallest Costa Rican *Stenospermation* (and certainly one of the smallest in the genus). Among Costa Rican species, it is most similar to *S. angustifolium* Hemsl., from which it differs in its horizontally splayed petiole sheaths (whence the species name) and longer inflorescence stipe. In the partial revision of Pérez de Gómez (1983), this species will key to *S. andreanum* Engl. of Panamá and Andean South America, and was originally so identified. However, the last-mentioned species has less extensively sheathed petioles, larger, grayish (rather than reddish-brown) -drying leaf-blades, and stouter spadices than *S. pteropus*.

SYNGONIUM

SYNGONIUM CASTROI Grayum, *spec. nov.* TYPE: COSTA RICA. Puntarenas: P. N. Corcovado, Cerro Brujo, 8° 38' N, 83° 35' W, 600 m, 23 Jan 1991, E. Castro 242 (HOLOTYPE: USJ-49640!).

Species aspectu cum *Syngonio llanoensi* Croat optime congruens, sed differt vagina petiolari usque ad basim laminae plerumque non extensa inflorescentiis multo parvioribus.

[Appressed-climbing] epiphytes. Petioles ca. [9–]20–21 cm, sheathed for ca. 75 [–100]% their total length, the cross-sectional shape not described. Leaf-blades simple, 17.6–32.9 × [4.9–]5.0–7.4[–8.6] cm, lanceolate to lance-elliptic [or oblanceolate], cuneate [or rounded] to the minutely auriculate base (auricles to ca. 4.5 × 3.5 mm, directed ± backward), brittle ("quebradizas"), with ca. [2–]8–9 primary lateral veins per side. Infls. 3 per axil. Peduncles to at least 6.3 cm. Spathe "blanca." Spadix ca. 3.8 × 0.9 cm, "amarillo." Ripe syncarps unknown.

Osa Peninsula [and head of Golfo Dulce], Costa Rica; [150–]600 m; January.

ADDITIONAL SPECIMEN EXAMINED. COSTA RICA. Puntarenas: between Chacarita and Rincón de Osa, ca. 6 km W of Interamerican Highway at Chacarita, 8° 45' N, 83° 18' W, ca. 160 m, *Croat & Grayum 59733* (MO [2 sheets]).

Syngonium castroi is distinctive in its simple, narrow leaf-blades minutely auriculate at the base, and small, apically subtruncate spadices. Because of its simple, scarcely lobed leaf-blades, this species would fall into the probably artificial sect. *Oblongatum* Croat (1981). The species with the most similar leaf-blades is the Panamanian *S. llanoense* Croat (1981), which differs in having the petiole sheaths virtually always extending to the leaf base, and much larger (more than twice as long) inflorescences. The new species bears some resemblances to the sympatric *S. laterinervium* Croat (1981), but the latter also has larger inflorescences (in addition to consistently trifoliate leaf-blades).

Syngonium castroi is definitely known only from the type specimen. The above-cited paratype, a sterile collection, is tentatively referred here solely on the basis of leaf shape. It differs from the holotype in certain details (all square-bracketed material in the description and distribution statement pertains only to the paratype).

This new species is dedicated to Emilio Castro, formerly associated with USJ, who collected the first (and, to date, only) fertile specimen.

SYNGONIUM RAYI Croat & Grayum, *spec. nov.* TYPE: CULTIVATED. Grown at Selby Gardens [originally collected at La Selva Biological Station, Prov. Heredia, Costa Rica, in early October, 1985 (*J.T. Atwood s.n.*)], 30 May 1990, *H. Luther s.n.* (HOLOTYPE: INB!; Isotypes: MO, PMA, SEL).

Species aspectu cum *Syngonio oduberi* T. Ray optime congruens, sed differt petiolis lobis laminaribus posticis relative longioribus.

Scandent epiphytes, fertile ca. 2–3 m above the ground. Petioles ca. (3.6–)8.4–22.5 cm, sheathed for ca. 58–94+% their total length, the cross-sectional shape not described. Leaf-blades simple, ca. (5.6–)10–24 × (2.5–)3.5–13 cm, ovate, oblong-ovate or oblong-deltate to elliptical, lance-oblong, or lanceolate, cordate to sagittate or hastate at base, dark green to purplish and matte to velvety adaxially, with ca. (3–)4–11 primary lateral veins per side. Infls. 1–4 per axil. Peduncles ca. 2.2–5.2 cm. Spathe tube green externally, dark wine-red within; lamina cream-white. Spadix ca. (6.0–)8.1–9.4 × 0.4–0.7 cm, the male portion white. Ripe syncarps unknown.

Costa Rica (Fila Costeña, Cordillera de Guanacaste, Atlantic slope Cordilleras de Tilarán and Central, Barra del Colorado region) to eastern Panamá (Cerro Jefe, San Blas); 0–1000(–1500) m; May–July, December.

ADDITIONAL SPECIMENS EXAMINED. COSTA RICA. Alajuela: Cerro las Nubes, Macizo Miravalles, 1500 m, *I.A. Chacón 85* (CR); Reserva Forestal de San Ramón, ca. 10 km west of Laguitos, along Río San Lorencito, 10° 18' N, 84° 34' W, 850–1100 m, *Hammel, et al. 15263* (MO). Guanacaste: Parque Nacional Rincón de

la Vieja, the SE slopes of Volcán Santa María, above Estación Hacienda Santa María, 10° 47' N, 85° 18' W, 900–1200 m, *Davidse, et al.* 23405 (MO). Heredia: near the Río Puerto Viejo, about 2 km upstream from the confluence with Río Sarapiquí, formerly “Finca La Selva” of L.R. Holdridge, 10° 26' N, 84° 0' W, 100 m, *Burger & Stolze* 5859 (CR); Finca La Selva, the OTS field station on the Río Puerto Viejo just E of its junction with the Río Sarapiquí, [ca. 100 m], *Grayum* 2281 (DUKE), 2435 (DUKE), 2895 (DUKE), 2959 (DUKE), *Hammel* 12462 (DUKE), *Hammel & Trainer* 10779 (DUKE); La Selva Reserve, *Lee s.n.* 4/8/1984 (MO-3304465); Finca El Bejuco, S base of Cerros Sardinal, Chilamate de Sarapiquí, 10° 27' N, 84° 04' W, 70–100 m, *Ray* 114 (MO), 139 (MO). Limón: Refugio Nacional de Fauna Silvestre Barra del Colorado, between Río Chirripocito and R. Sardina, 10° 38' N, 83° 45' W, ca. 10–15 m, *Grayum* 9747 (CR,MO); Cantón de Pococí, Parque Nacional Tortuguero, northern terminus of Lomas de Sierpe, S from Río Tortuguero, 10° 29' N, 83° 31' 30" W, 8–25 m, *Grayum, et al.* 11164 (INB,MO). San José: Cantón de Tarrazú, Cerro Nara y alrededores, 9° 29' 20" N, 84° 00' 40" W, 1000 m, *M.M. Chavarría & Solís* 916 (INB); Tarrazú, Nápoles, ladera Oeste de Cerro Pito, 9° 04' 50" N, 84° 04' 10" W, 1500 m, *G. Herrera, et al.* 8805 (CR); Cantón de Dota, Z. P. Cerro Nara, falda SW del Cerro Chingo, 9° 29' 05" N, 84° 01' 02" W, 400–500 m, *J.F. Morales & González* 4564 (INB [3 sheets]).

PANAMA. Panamá: Cerro Jefe, NE of Panama City, c. 9° 15' N, 79° 30' W, 850–900 m, *McPherson* 9740 (MO). San Blas: Cerro Obu [9° 22' N, 78° 47' W], 400–500 m, *de Nevers, et al.* 8040 (MO).

CULTIVATED. Growing in Selby Display House [no locality data], *Atwood & Uguccioni s.n.*, 15 May 1991 (MO-3865329).

Syngonium rayi is characterized by its smallish size, clear (rather than milky) sap in all vegetative organs, and simple, usually sagittate to subhastate leaf-blades, dark green and velvety adaxially, with finely crispate-undulate margins. Most of these features are shared with the allopatric *S. oduberi* T. Ray (endemic to the Golfo Dulce region of Pacific Costa Rica), from which *S. rayi* differs in its longer (relative to the leaf-blades) petioles and posterior laminar lobes. Although *S. oduberi* was assigned by Croat (1981) to his sect. *Oblongatum*, *S. rayi* will key to sect. *Cordatum* Croat, because of its more prominent posterior leaf-blade lobes.

Although I dislike selecting a specimen from cultivation as type, *Syngonium rayi* is a distinctive species, and nearly all of the wild collections are unicates. Mature individuals of this species are rare in the wild; it has been collected in flower only about a dozen times. At the La Selva Biological Station, where *S. rayi* is best known, fruiting specimens have never been observed (presumably due to the great scarcity of flowering individuals). Nonetheless, juvenile plants believed to represent this species (e.g., *Lee s.n.* 4/18/1984) are abundant along forest trails, suggesting that vegetative multiplication may be involved.

This species, as presently circumscribed, is rather a variable one, especially as regards leaf-blade size and shape. However, the variation appears continuous, and no

locality outside the Sarapiquí region (Prov. Heredia, Costa Rica) has yielded more than a single collection.

We take pleasure in dedicating this species to Thomas S. Ray (DELS), who recognized it as new during the course of his doctoral research at the La Selva Biological Station in the 1970's. In addition to having contributed significantly to our understanding of *Syngonium* and Araceae in general, Tom is well respected for his conservation work in the Sarapiquí region.

XANTHOSOMA

XANTHOSOMA DEALBATUM Grayum, *spec. nov.* TYPE: COSTA RICA. Puntarenas: along road at base of hills behind Playa Espadilla, SE of Punta Quepos, 9° 23' N, 84° 09' W, ca. 10 m, 24 Sep 1984, *M. Grayum & P. Sleeper* 3927 (HOLOTYPE: CR-110826!, CR-110827!).

Species aspectu cum *Xanthosoma violaceo* Schott optime congruens. sed differt laminis foliorum abaxiale valdius dealbatus petiolis pedunculis spathis extus non glaucis spadicebus parvioribus.

Stem subterranean, a subglobose corm ca. 3 cm diam. Petioles ca. 46–89 cm, sheathed ca. 30–43% their total length., terete beyond sheath. Leaf-blades simple, ca. 31–57 × 17.5–32.0 cm, lance-deltate to ± pandurate, sagittate at base, strongly bicolored (matte and whitened abaxially), with ca. 5–10 adaxially ± sunken primary lateral veins per side; posterior rib naked for 0–0.8 cm. Infls. to at least 4 per axil. Peduncles ca. 18–37 cm. Spathe tube uniformly green externally and within; lamina white to cream-colored. Spadix ca. 10.7–10.5 × 0.5–0.7 cm, the fertile male portion white; fertile female portion (stigmas) pale yellow. Ripe frts. yellow-orange to orange (with axis of female portion of spadix somewhat paler).

Pacific slope of Costa Rica south from the Río Grande de Tárcoles; 0–200(–600+) m; June–July, September–October.

ADDITIONAL SPECIMENS EXAMINED. COSTA RICA. Puntarenas: Reserva Forestal Golfo Dulce, Osa Peninsula, Rancho Quemado, ca. 15 km W of Rincón, in bottom of S end of valley along Río Riyito, 8° 40' N, 83° 34' W, 200 m, *Hammel, et al.* 16977 (CR); along Quebrada Banegas, ca. 4 km W of Rincón de Osa, 8° 41' N, 83° 32' W, ca. 40 m, *Grayum* 4112 (MO, non vidi); Reserva Biológica Carara, along S side of Río Grande de Tárcoles from Carretera Costanera E to vicinity of Paso Rieles (N base of Lomas Pizote), 9° 48' N, 84° 36' W, 20 m, *Grayum & Warner* 8369 (MO); near Rincón, where new road from Piedras Blancas crosses small creek, 8° 43' N, 83° 29' W, ca. 160 m, *Grayum, et al.* 3426 (CR); Rincón de Osa, along ridge between Quebrada Aparicio and Q. Aguabuena, 8° 42' N, 83° 31' W, 200–400 m, *Grayum, et al.* 4016 (CR); valley of Laguna Chocuaco, ca. 9 km W of

Rincón de Osa, 8° 41'–43' N, 83° 34' W, ca. 200 m, *Grayum*, et al. 4072 (CR), 4080 (CR [2 sheets]); Conte [Península de Burica], C.E. Valerio CEV-90 (USJ).

Xanthosoma dealbatum is distinguished by its cormose habit, sagittate leaf-blades strongly whitened abaxially (whence the name), orange fruits, and Pacific lowland habitat. It is most similar to the cultivated (and naturalizing) *X. violaceum* Schott, from which it differs in its more markedly bicolored leaves, otherwise non-glaucous foliage, and smaller spadices. The leaf-blades of *X. violaceum*, though glaucous abaxially, are not whitened in marked contrast to the adaxial surface; furthermore, *X. violaceum* tends to have glaucous petioles, peduncles, etc.

All collections of *Xanthosoma dealbatum* seen to date are from Puntarenas Prov., Costa Rica. Plants of this species are seasonal, at least in the northern portion of their range, with only the corms surviving the drier periods of the year. This is typical of other cormose *Xanthosoma* species of the Costa Rican Pacific slope, i.e., *X. mexicanum* Liebm. and *X. wendlandii* (Schott) Schott.

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**NEW SPECIES OF *APHANACTIS*, *CALEA*, *CLIBADIUM*, AND *TRIDAX*
(*HELIANTHEAE*: *ASTERACEAE*) FROM ECUADOR AND PERU**

Harold Robinson

Department of Botany, National Museum of Natural History, Smithsonian Institution,
Washington, D.C. 20560 U.S.A.

ABSTRACT

Aphanactis hutchisonii, *Calea harlingii*, *Clibadium websteri*, and *Tridax cajamarcensis* are described as new. The new combination *Wedelia rudis* is also made.

KEY WORDS: Asteraceae, Heliantheae, *Aphanactis*, *Calea*, *Clibadium*, *Tridax*, *Wedelia*

The preparation of the Heliantheae treatment for the Flora of Ecuador has resulted in the discovery of undescribed species in a variety of genera, a *Calea* and *Clibadium* in Ecuador, and species of *Aphanactis* and *Tridax* in Perú. A new combination is made in *Wedelia* for *Zexmenia rudis*.

The following undescribed *Aphanactis* was discovered in the backlog of the late Dr. José Cuatrecasas almost immediately after publication of a paper describing four new species of that genus (Robinson 1997).

APHANACTIS HUTCHISONII H. Rob., *spec. nov.* TYPE: PERU. Amazonas: Chachapoyas, Cerros Calla Calla 26 kms above Leimebamba on road to Balsas, 3360 m, 16 Oct 1964, *Hutchison & Wright 6990* (HOLOTYPE: UC; Isotype fragment: US).

Plantae rosulatae et flagelliformes ca. 4 cm altae; caules villosi. Folia primaria in rosulis subacaulibus elliptica 2.5-3.5 cm longa, 0.8-1.7 cm lata, base et apice acuta, margine pauce remote serrulata supra et subtus villosa subtus pallidius longitudinaliter 7 aut 9 nervata; flagella procumbentia ad 10 cm longa, internodis 0.5-2.0 cm longis; foliis oppositis ellipticis 0.1-0.7 cm longis, 0.3-0.9 cm latis, integris vel pauce serrulatis utrinque villosis. Inflorescentiae terminales unicapitatae, pedunculis brevibus. Capitula ca. 4 mm alta, 7 mm lata; squamae involucri ca. 8 pallide virides 4.0-4.5 mm

longae, ca. 2.5 mm latae, apice acutae extus dense villosae; paleae anguste subulatae 0.5-1.8 mm longae. Flores radii ca. 5; corollae flavae ca. 2.5 mm longae, tubiformes distaliter inaequaliter 3 aut 4-lobatae extus dense plerumque antrorse pilosae in lobis pauca pilosulae, ductis 5 aut 6. Flores disci 25-30; corollae flavae ca. 2 mm longae in tubis et basis faucium dense plerumque antrorse pilosae in limbis plerumque glabrae, tubis ca. 0.7 mm longis, faucibus ca. 1 mm longis, lobis ca. 0.6 mm longis; thecae antherarum ca. 0.5 mm longae. Achenia ca. 2 mm longa glabra; pappus nullus. Grana pollinis in diametro ca. 27 μ m.

The label describes the plants as velvety prostrate rosettes, flowers yellow. *Aphanactis hutchisonii* was initially determined by Cuatrecasas as *A. villosa* S.F. Blake of Perú and southern Ecuador, and the plant is distinctly villous. However, the heads of *A. villosa* and the other southern species *A. boliviana* H. Rob. have 10 or fewer disk florets. The present species is most distinct in the rather Gnaphalioid habit with large rosette leaves and small leaves on spreading branches. The habit is only moderately approached by *A. boliviana* with its spreading branches that have long basal internodes. By its larger heads, the present species is related to the more northern members of the genus that have not been known previously south of Ecuador. The genus is characterized by peduncles that elongate after the heads mature, a process that apparently had yet to occur in the type collection of *A. hutchisonii*.

CALEA HARLINGII H. Rob., *spec. nov.* TYPE: ECUADOR. Loja: Vilcabamba - Yangana road, km 12-15, ca. 1900 m, 21 April 1980, *Harling & Andersson 18490* (HOLOTYPE: US; Isotype: GB).

Plantae tenuiter fruticosae ad 1 m altae mediocriter ramosae; caules flavo-brunnescentes leniter rubrotincti in maculis elongatis nigri, internodiis plerumque 2.5-4.0 cm longis. Folia opposita, petiolis ca. 5 mm longis; laminae herbaceae 3.0-5.5 cm longae, 2.0-3.2 cm latae, base late obtusae, margine subintegrae remote 7-8-crenulatae apice breviter acutae supra planae scabridulae subtus pallidiores minute puberulae vel hispidulae minute glandulo-punctatae 3-4 mm supra basem trinervatae. Inflorescentiae in ramis et ramulis foliosis terminales; pedunculis ad 10 mm longis minute puberulis. Capitula ca. 1 cm alta, 5-6 mm lata; bractae involucri ca. 20, subimbricatae in sereibus ca. 4 dispositae, bractea basilaris unica parva oblonga ca. 2 mm longa, 1 mm lata, apice leniter herbacea, bractae inferiores laxae congestae, bractae ceterae subcoriaceae 2-7 mm longae, 1.0-2.5 mm latae, apice anguste rotundatae vel breviter acutae sordidae scariosae plana extus stramineae 5-7 atro-lineatae; paleae scariosae ellipticae 5.5-6.0 mm longae, apice lacinatae argute acutae extus glabrae. Flores radii 2 aut 3; corollae flavae glabrae, tubis ca. 2.0-3.5 mm longis, limbis ca. 4 mm longis et 2 mm latis. Flores disci ca. 15; corollae flavae glabrae ca. 5.5 mm longae, tubis ca. 2 mm longis, faucibus anguste campanulatis ca. 2.5 mm longis, lobis leniter inaequalibus exterioribus ad 1.2 mm longis interioribus 0.8 mm longis; thecae antherarum 1.8 mm longae; appendices apicales extus glanduliferae. Achenia ca. 3 mm longa omnino longe setulifera; squamae pappi 20-22, ca. 4.5 mm longae. Grana pollinis in diametro ca. 33 μ m.

Calea harlingii is known only from the type collection cited from secondary scrub at about 1900 m in elevation. Relationship seems closest to *C. umbellulata* Hochr. that also occurs in Loja, but its achenes are setuliferous rather than essentially glabrous, its stems have minute pubescence rather than being hirtellous, and its disk corollas are slightly but distinctly zygomorphic.

CLIBADIUM WEBSTERI H. Rob., *spec. nov.* TYPE: ECUADOR. Pichincha: Cerro Negro, ca. 3.5 km (airline) E of Nanegalito, disturbed lower montane cloud forest, 00° 03-03.5' N, 78° 39' W, 1720-1760 m, 26 June 1996, *Webster, Hierro, & Canfield 31930* (HOLOTYPE: US; Isotypes: DAV,QNCE). Paratype: ECUADOR. Pichincha: Parroquia Nanegalito, cloud forest on western slopes of Cerro Negro, 2.5-3.0 km airline NE of Nanegalito, 2000-2050 m, 00° 04' N, 78° 39' W, 8 Sept 1993, *Webster, Elsas, & Morgan 30474* (DAV,QNCE,US).

Frutices erectae 2.0-2.5 m altae parce ramosae; caules subtereti dense albo-lanati. Folia opposita, petiolis 1-5 cm longis, longe albo-lanatis; laminae ovatae vel ovato-ellipticae, 10-22 cm longae, 3-8 cm latae, base breviter acutae, margine plerumque valide 25-35-serratae vel pauce serrulatae apice anguste acuminatae supra rugulosae dense pilosae subtus in nervis et nervulis exsculptis hirsutis in areolis hirsutulis hispidis et hispidulis, nervis secundariis subpinnatis in partibus ca. 2-3 cm supra basem nervis valdioribus et ascendenterioribus. Inflorescentiae plerumque tripartitae in partibus glomerulatae, "pedunculis" 0.5-2.0 cm longis; glomerulae in diametro 1.2-2.2 cm sphaericae, in fasciculis bracteis basilaribus lanceolatis ca. 5 mm longis pilosulis. Capitula 2-4 mm alta et lata, bracteis involucri exterioribus sterilis 4 vel 5 oblongis, ca. 3 mm longis, 2.0-2.5 mm latis, plerumque subcoriaceis laevibus apice breviter acutis membranacioribus and venulosioribus saepe recurvatis vel incurvatis extus puberulis; bracteis femineis 5 aut 6 membranaceis late ovatae vel ovato-ellipticis ca. 3 mm longis, 1.5-2.0 mm latis, apice breviter acutis membranacioribus et recurvatis extus glabris margine et apice pilosulis; paleis tenuiter membranaceis ellipticis vel lanceolatis 2.0-2.5 mm longis argute acutis et distaliter erosis distaliter pilosulis. Flores feminei 5 aut 6; corollae albae cylindricae ca. 2 mm longae, inaequaliter 4-lobatae, lobis 0.15-0.35 mm longis. Flores masculini plerumque 3; corollae albae, ca. 3 mm longae, tubis 0.7-0.8 mm longis et latis, glabris, faucibus late et abrupte urceolatis, ca. 1.8 mm longis, ca. 1.2 mm latis, glabris, ductis rubris 5, lobis triangularibus ca. 0.4 mm longis extus dense pilosulis vel hirtellis; thecae antherarum ca. 1.2 mm longae; appendices apicales nigrae ca. 0.4 mm longae. Achenia feminei obovoidea, 1.5-2.0 mm longa, 1.2 mm lata in tertiam superiorem hirtella, pedicelis deciduis ca. 0.5 mm longis. Achenia masculini angusta ad 2 mm longa plerumque dense hirtella. Grana pollinis in diametro ca. 25 µm.

Clibadium websteri is yet another of the members of the genus with glomerulate inflorescences. It is most distinct in the long wooly pubescence of the stems and the abruptly urceolate throats of the disk corollas.

TRIDAX CAJAMARCENSIS H. Rob., *spec. nov.* TYPE: PERU. Cajamarca: 9 kms N along road from Cajamarca to Bambamarca, ca. 9000 ft., 8 Jan 1983, *King & Bishop 9114* (HOLOTYPE: US; Isotypes: MO,USM). Paratypes: PERU. 5 km N along road from Cajamarca to Bambamarca, ca. 8600 ft., 8 Jan 1983, *King & Bishop 9108* (MO,US,USM); Cajamarca: Celendín, Sucre, 3300-3500 m, 13 Mar 1969, *Riccio 6357*, in part (US,USM); Contumazá, El Granero, ladera abierta, 2800 m, 4 June 1983, *Sagástegui & Lopez 10633* (HUT,US); Alrededores de Contumazá, ladera, 2600 m, 26 June 1983, *Sagástegui, Mostacero, & Alvitez 10691* (HUT,US); Cajamarca, Santa Apolonia - Cumbe Mayo, 3000 m, borde de carretera, 19 Nov 1983, *Sagástegui, et al. 11286* (HUT,US).

Frutices tenues declinatae inferne multo ramosae superne parce alterne ramosae; caules teretes striati brunnescentes patentiter scabriduli. Folia plerumque opposita superne alterna, petiolis nullis; laminae lineares vel saepe lineari-lobatae ad 5 cm longae, 1-3 mm latae, margine integrae vel lobatae apice anguste rotundatae supra et subtus dense pilosulo-scabridulae, nervis secundariis solum in lobis. Inflorescentiae diffusae in capitulis erectis numerosis longe pedunculatis; pedunculis plerumque 8-20 cm longis dense stipitate glanduliferis. Capitula late campanulata 11-15 mm alta; involucae 9-18 mm latae; bractae involucri 4-seriatae ca. 25 oblongae, 2-7 mm longae, 1-2 mm latae, apice rotundatae margine breviter ciliato-fimbriatae extus glabrae vel subglabrae subapice minute scabridulae; paleae lineares 6-7 mm longae, 0.3-0.5 mm latae. Flores radii 6-8; corollae pallide purpureae, tubis angustis ca. 5 mm longis, limbis quadratis, ca. 7 mm longis et latis, apice late trilobatis. Flores disci ca. 20-25; corollae obscure distaliter purpureae ca. 6 mm longae, tubis ca. 1.8 mm longis, superne pilosulis, faucibus ca. 3.5 mm longis, lobis ca. 0.6 mm longis; thecae antherarum nigrae, 2.5-2.8 mm longae; appendices apicales pallidiores. Achenia ca. 3 mm longa, sericeo-setifera; setae pappi fulvae, ca. 3 mm longae, dense plumosae. Grana pollinis in diametro 32-35 μm .

Tridax cajamarcensis has passed at various times under broad concepts of *T. angustifolia* Spruce ex Benth. or *T. peruviana* Powell. The new species differs from both by the generally smaller heads, the essentially glabrous outer surfaces of the involucre bracts, and the tendency of the linear leaves to be lobed.

WEDELIA RUDIS (Baker) H. Rob., *comb. nov.* BASIONYM: *Zexmenia rudis* Baker in Martius, *Fl. Bras.* 6(3):188. 1884.

The validation usually cited for the combination is in Baker (1884) where the herbarium name *Wedelia rudis* occurs only in synonymy. The species was not included among the many *Wedelia* combinations provided by Turner (1992).

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